A

GEOLOGICAL

AND

AGRICULTURAL SURVEY

OF THE DISTRICT ADJOINING

THE

ERIE CANAL,

IN THE STATE OF NEW-YORK.

TAKEN UNDER THE DIRECTION OF THE

HON. STEPHEN VAN RENSSELAER.

PART I.

CONTAINING

A DESCRIPTION OF THE ROCK FORMATIONS;

TOGETHER WITH A

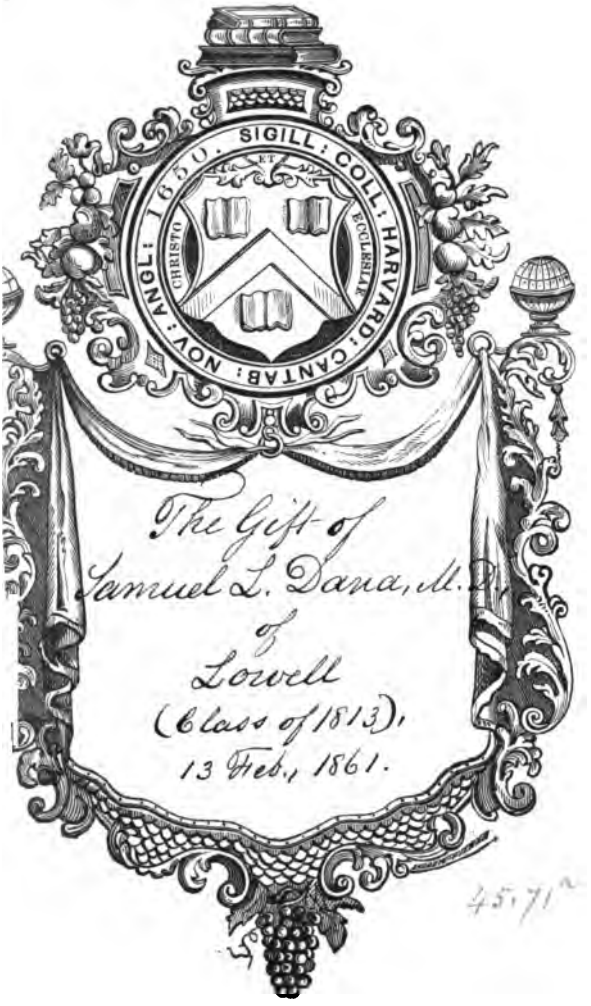
GEOLOGICAL PROFILE,

EXTENDING FROM THE ATLANTIC TO LAKE ERIE.

ALBANY:

PRINTED BY PACKARD & VAN BENTHUYSEN.

1824.



Plaster Bels
Pendulum

ADVERTISEMENT.

The geological and agricultural surveys heretofore taken by Mr. Van Rensselaer, have been published and distributed gratuitously. This was published with the same intent also. But Mr. V. R. has since given me permission to direct the remainder of the edition to be sold at $1.50 each, after reserving a sufficient number for scientific institutions, &c.

All the money received for these will be applied solely to agricultural improvements.

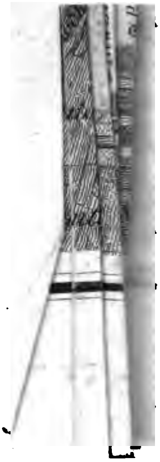
A. EATON.

Note.—Orders for these books may be sent to Messrs. D. Steele & Son, or Messrs. Websters & Skinners, booksellers, Albany.

[*Corrections, to be added to those on the* 16*th page.*]

At page 24, *Ferriferous Salte*, should be *Ferriferous Slate.*

At page 113, in the 18th line from the bottom, after the word springs, interline the words, *and gypsum.*



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By Amos Eaton

PART I.

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TO THE

HON. STEPHEN VAN RENSSELAER.

The following pages contain the result of my geological investigations in the vicinity of the Erie Canal, so far as I have been able to ascertain the rock formations. Agreeably to your directions, I have extended the profile view of the rocks across Massachusetts to the Atlantic, about one hundred and eighty miles east from the eastern extremity of the canal. Maclure and James have given sketches of great extent, founded on hasty and very general observations; but no geologist on either continent has hitherto attempted to give a transverse view of rock strata across such an extensive district, from a particular examination of each individual rock. This section is about five hundred and fifty miles in extent, stretching across nine degrees of longitude, and crossing both of the great primitive ranges of New-England, (the White Mountain and Green Mountain ranges,) also the broad transition and secondary ranges of the eastern and western parts of the state of New-York. Therefore if your directions have been faithfully executed, you will have presented to the science more *elementary facts in a connected view*, than any other individual.

As I have from time to time received your particular directions, and communicated to you every material step which I have taken, I have but few remarks to make, introductory to the following printed report, excepting such as are due in regard to the nomenclature. In your last letter, before you set off for the seat of government, after telling me that Prof. Silliman's health would not admit of his accompanying me to any part of the section, you urged the necessity of my

conferring with some other distinguished geologists, in regard to the few changes in the geological nomenclature which I proposed. Accordingly, I sent a printed circular to several hundred gentlemen, who had given more or less attention to the science, exhibiting my proposed new names, and requesting their remarks. The answers which I have received from many of them, particularly from Prof. Dewey and Mr. Hitchcock, have been very useful to me—confirming me in my opinion in many cases, and causing me to make additions and alterations in others. Though I have been greatly assisted by many gentlemen of extensive observation, with whom I have fallen in at various points of the section, Prof. Joel Nott, of Union College, is the only professor of this science with whom I have been upon the ground; and an accident deprived me of his interesting reflections, excepting at a limited distance. This happened to be, however, at those places best calculated to settle the question respecting that extensive slate rock which embraces the gypsum, shell limestone, water limestone, &c.

I have adopted the European name in every case where an *established name* would apply; but where I have found no settled name which is applicable to the rock under consideration, I have given it a *descriptive* name, in imitation of Bakewell's *metalliferous*, and Conybeare & Phillips' *saliferous* rocks. The reader may therefore prefix any favorite name he chooses, and consider the name which I have given as part of a definition. I would not be understood to say, that I cannot find names in some authors, which have been applied to rocks resembling *some parts* of our western rocks; but the same names are differently applied by different authors, or even by the same author. Multitudes of elegant treatises on geology are written by those who never examined the rocks they describe, excepting in hand specimens. Such works I consider of no authority, but as always calculated to mislead.

To identify the secondary rocks of our district with those of Europe, was, from the beginning of my examinations, a principal object. For this purpose, I examined every European treatise of reputation, and made careful comparisons of specimens. I found no difficulty in effecting this object with all rocks, excepting those which are above the salt formation. And even here, I find every rock in some way referred to by European authors; but their names seem to have been given to insulated beds and patches, without any view to those extensive strata which are found in our district. Several European writers have complained of their contracted strata, so made by the approximation of their primitive ranges; whereas our secondary rocks, along the canal line, are several hundred miles in extent, and remarkably uniform in their leading characteristics.

After examining our rocks with as much care and accuracy as I am capable of doing, I venture to say, that we have at least five distinct and continuous strata, neither of which can with propriety take any name hitherto given and defined in any European treatise which has reached this country. The late work of Phillips and Conybeare describes many of the beds, and some of the varieties found among the rocks referred to. But the nomenclature of these very able geologists cannot be adopted in our district, without mangling and distorting the unprecedented simplicity of our rock strata.

Bakewell, an experienced European geologist, who is honourably noticed in various parts of Rees' Cyclopædia, says, "I believe, that an enlarged view will be sufficient to prove, that all the stratified rocks above red sandstone are local formations, which had their origin in detached hollows, or seas of great extent, and are limited to certain portions of the globe." Whether Bakewell's opinion is a correct one, and is applicable to our district or not, I acknowledge myself unable to identify those distinctly characterized strata of the

Erie Canal line, which are above the saliferous rocks, with those which are described in European books, or designated by specimens labelled by European geologists, and sent to this country.

Geology has its peculiar difficulties, from which all other sciences are exempt. Questions in chemistry may be settled in the laboratory by experiment. Mathematical and philosophical questions may be discussed, while the materials for discussion are ready furnished by our own intellectual reflections. Plants, animals and minerals, may be arranged in the museum, and all questions relating to their intrinsic principles may be discussed with facility. But the relative positions, the shades of difference, the peculiar complexions, whether continuous or in subordinate beds, are subjects of enquiry in settling the characters of rocks, which can be judged of while they are in *situ* only.

The alluvial deposits hide probably ninety-nine hundredths of all our secondary strata from our inspection. We are therefore compelled to traverse every stream of water, to search out every naked cliff, to descend into every cavern, to examine wells, water race-ways and ditches, to obtain a few elementary facts. Then we must travel back and forth, comparing, conjecturing, often almost despairing, before we can arrive at such a knowledge of the strata, that we dare trust our views before the doubting public. After all this labour and pains, we are subject to have our feelings outraged, or rather to have our indignation excited beyond endurance, at perceiving public confidence in our labours weakened by the arrogant periods of a sophomoric scribbler, whose ignorance of our subject is scarcely outmeasured by his want of fidelity.

Your liberality and disinterested patronage are my strong safeguard in the present case. You have furnished every facility for perfecting the work; you have set no limits to

my expenses, nor to those of the engravers or printers. All the defects are therefore strictly my own; resulting, however, neither from want of industry, or of opportunity for observation.

If the preceding remarks have not given you full satisfaction in regard to the liberties I have taken with geological nomenclature, against which you cautioned me, I would add my length of servitude in the cause of this science as an apology. I was the first, in point of time, who attempted a *particular classification* of American rocks.* I have given twenty-four courses of geological lectures on and near our section, and the number of my pupils exceeds two thousand. I had travelled more than three thousand miles on foot, and two thousand by water and carriage conveyance, in search of geological facts, before I became a subject of your patronage. I have added more than five thousand miles of land and canal travelling, in pursuit of the same object, during the last four years, while my expenses have been paid, and my efforts richly rewarded by your munificence. You will not from this infer, that I am endeavouring to convince you that I am infallible in my opinions; but that I may be excused for taking liberties in some questionable cases, which might have been deemed arrogant in a younger man.

The young gentlemen, Messrs. M. H. Webster and J. Eights, whom you appointed as assistants, discharged their respective duties with ability and the strictest fidelity. Mr. Webster's discriminating talent as a naturalist, and Mr. Eights' taste for drawing, seemed to be indispensable in aid of your purpose. The views were all taken by Mr. Eights, excepting that of Black Rock village; the latter was procured and presented by Gen. P. B. Porter.

* M'Clure had given an excellent view of the geographical location of the primitive, transition, and secondary formations of the United States, before I published my first edition of the Index to the Geology of the Northern States.

My notes taken during the examination, are sufficiently copious to furnish materials for double the number of pages here given. I had also collected materials for a pretty extensive article on Peculiar Formations. But on a review of my manuscripts, it appeared to me, that a mere dry collection of facts ought to be compressed as much as possible.

I conclude by saying, that if I have not misunderstood your directions, this report is as perfect as I am capable of making it.

Respectfully submitted,

AMOS EATON.

Troy, (N. Y.) Jan. 22, 1824.

DIRECTIONS

For Students in Geology.

This survey was taken, and the report published, for the benefit of those who wish to become acquainted with North American rocks, and their most interesting contents and associations. Those who are not satisfied with hand specimens collected by others, may collect for themselves, and see all our rocks in place, by following these directions.

Between the highest part of the ridge in Savoy on our section, and the top of the Williamstown Mountain, (a distance of eighteen miles,) *granite*, *gneiss*, *hornblende rock*, *mica slate*, *talcose rock*, *granular quartz*, *granular limerock*, *sparry limerock*, and *primitive argillite*, may be seen in place to good advantage. The granite, however, will be found only in layers and veins. A thorough student should cross the mountain both at the north and south ends of the town of Adams, where the roads now lead over to the east. The hornblende rock is exhibited in a very interesting manner, where the south road rises up into Savoy. The granite is most perfect on the north road.

Three of the rocks just mentioned may be collected at the Noses and Little Falls: I mean the granite, gneiss, and hornblende rock. They are found in greater perfection there in loose boulders, how-

ever, than in place. Williamstown Mountain being but about twenty-four miles east of the commencement of the canal, it is worth a journey that distance, to see all the primitive rocks in place.

Transition argillite may be examined to good advantage at the Cahoes. *Calciferous sandrock*, at Flint Hill. *Metalliferous limerock*, one mile east of Schoharie-Kill, and along the ledge south of Canajoharie. *Graywacke*, at Alexander's Bridge. *Old Red Sandstone*, on Catskill Mountains, or on the Hudson below the north bluff of the Palisadoes? *Millstone grit*, two miles south of Utica, in the falls of Starch-Factory Creek; it is in boulders two miles west of Oriskany, on the south side of the canal. *Saliferous rock*, at Oak-Orchard Creek. *Grey band*, on a creek eighteen miles east of Lockport, and at Genesee Falls. *Ferriferous slate*, Genesee Falls. *Ferriferous sandrock*, Genesee Falls. *Calciferous slate*, Limestone Creek in Manlius. *Geodiferous limerock*, Lockport. *Cornitiferous limerock*, Black Rock village. *Pyritiferous rock*, Eighteen-Mile Creek on the south shore of Lake Erie. *Amygdaloid* and *greenstone trap*, on Connecticut River, or the Palisadoes on the Hudson.

Whoever takes the trouble to examine these localities, may make himself acquainted with all North American rocks, according to the nomenclature adopted in this report. He may find specimens in the same localities to fit any other plan of arrangement, as far as such plan will apply to our rocks. A southern traveller may take the Palisadoes in his way, while passing up the Hudson in the steam-boat. He may make his first stop at the Palisadoes, and his next at West Point. At the

latter place he will find granite, gneiss, and hornblende rock in place. After leaving the steam boat, and ascending the canal to Troy, he may make an excursion to Williams College by land. On returning to the canal, he will not leave it again until he reaches Lake Erie; then he may take a carriage to Eighteen-Mile Creek.

Thus, by merely taking carriage to Williams College, thirty miles, and eighteen miles along the south shore of Lake Erie, all our rocks may be seen in place, by the traveller in canal packets and steam-boats.

CONTENTS.

☞ The General Section is supposed to be on the south side of the observer—Mr. Hitchcock's on the north. The former must be placed at the beginning of the book, the latter at the end.

CORRECTIONS.

At the 45th page, 7 lines from the bottom, make a reference to the margin after the words New-Jersey shore, and there write:

These rocks extend a few miles into the state of New-York.

At page 93, 8 lines from the bottom, after the words, coal formation, make a reference to the margin, and there write:

Geologists may hereafter decide, that there is none of the true Old Red Sandstone on Connecticut River, or under the Palisadoes; but that all these red rocks belong to Mr. Hitchcock's *coal formation*, or to the *saliferous formation* of some geologists, or to the secondary *breccia* of others.

GEOLOGICAL NOMENCLATURE.

UNFORTUNATELY for Geology, Werner, the father of the science, never published an elementary system. We depend for a knowledge of his views of elementary classification, definitions, &c. on the notes of his pupils taken down at his lectures; and a few of his essays, which appeared in public journals. Kirwan, of Dublin, and Jameson, of Edinburgh, made separate attempts at an exposition of the Wernerian system in English, during the life of Werner. They differed considerably, however, in their views; and varied more or less in their definitions of most rocks. . . .

There were, as might be expected, many chasms in the system of Werner to be filled up, as new discoveries were made. But the recent custom among geologists, of cutting up and subdividing, seems to be upon the point of ruining the simplicity of the Wernerian arrangement, as the same custom among botanists has already nearly ruined the Linnean system of vegetables.

No theorizing is required for determining the succession of our transition and secondary rocks; because we have localities in abundance, where they may be seen in the order of arrangement in which their names are here given. But our primitive rocks cannot be inspected in a manner so satisfactory. Their highly inclined position, together with the limited extent of some, render certainty

often a difficult desideratum. Consequently geologists, in our country, who pursue truth with the greatest zeal, often differ in their opinion in regard to the arrangement of some of the primitive rocks. None, however, has created so much confusion as the varieties of Trap or Hornblende rock. Had Werner once declared to his pupils that there were but two distinct strata of hornblende rock, the Primitive and Basaltic, much confusion among geologists would have been saved. Perhaps no fact is more conclusively demonstrable, when limited to a consideration of American rocks; but we accept the suggestions of our cotemporaneous countrymen with great reluctance. We prefer shutting our eyes to facts, for the sake of manifesting our obsequiousness to "the great men of Europe."

To experienced geologists it is almost a matter of indifference, what name a writer gives to a rock, if he describes it from his own personal examination. Every line he writes will be more satisfactory, than as many pages composed by a closet theorist, who has not examined rocks in place.

I follow the Wernerian arrangement, excepting that I adopt, in part, the superincumbent class of Bakewell, and place old Red Sandstone in the Transition class, according to the latter author. I have not been able to discover any advantage in rejecting the Transition class, and adding the Tertiary; though very learned and ingenious geologists approbate the innovation.

The few names which I have added, were admitted with extreme reluctance; and, as it were, forced upon me for want of established names

which appeared to be appropriate. These names were constructed upon the principle recognized by Bakewell, Phillips and Conybeare, and some others. It is that of compounding the name of the *most important mineral embraced* in the rock, with an adjunct expressing *to bear.* Thus Bakewell calls the transition limestone the *Metalliferous* stratum; because it is the only limestone rock which often contains ores of metals in veins, &c. So Phillips and Conybeare name our red rock of the west, *Saliferous;* because it is the only rock which constitutes the floor of the salt formation.

The following are the only North American rock strata, with their subdivisions and subordinates, hitherto discovered and defined, according to my views of the subject. I have given the names of the principal minerals embraced in each rock also.

I. PRIMITIVE CLASS.

1. Granite.

Minerals. Hyaline quartz, felspar, mica, green, blue and red tourmaline, shorl, emerald, beryl, chrysoberyl, topaz, serpentine, calc spar, tabular spar, adularia, silicious spar, fluor spar, tremolite, sulphate of barytes, magnesian limestone, phosphate of lime, pinite, andalusite, zircon, lepidolite, epidote, zoisite, asbestos, augite, saclite, cocholite, talc, plumbago, gold, platina, silver, copper, iron, lead, tin, zinc, nickel, bismuth, tellurium, molybdena, tungsten, titanium, uranium.

2. Gneiss.

Subdivisions. Slaty gneiss.
Quarry gneiss.
Sandy gneiss.
Porphyritic gneiss.*

Minerals. Hyaline quartz, felspar, mica, garnet, adularia, carbonate of strontian, phosphate of lime, alum, copperas, spinelle, zircon, haydenite, plumbago, gold, silver, copper, iron, lead, tin, zinc, manganese, bismuth, antimony, molybdena, tungsten, titanium, uranium, arsenic, cobalt.

3. Hornblende Rock.

Subdivisions. Granitic Hornblende Rock.
Gneisseoid Hornblende Rock.
Slaty Hornblende Rock.
Porphyritic Hornblende Rock.
Sienite.†

Minerals. Hornblende, felspar, tremolite, grammatite, pinite, scapolite, epidote, zoisite, garnet, hyperstene, actynolite, diallage, silver, cobalt, arsenic, nickel, bismuth, tellurium, uranium, antimony, copper, tungsten.

* I have never seen porphyritic granite. I believe this variety of gneiss has been mistaken for it.

† I have seen no rock which can be called greenstone, with any propriety, as a distinct stratum. All these varieties are sometimes deep green, and sometimes greenish brown.

4. Mica-Slate.

MINERALS. Quartz, mica, garnet, sappare, staurotide, pinite, melanite, macle, shorl, gold, titanium, columbium.

5. Talcose Rock.

Subdivisions. Talcose Slate.
Chlorite Slate.*

MINERALS. Quartz, talc, mica, garnet, magnesian limestone, carbonate of magnesia, steatite, asbestos, amianthoid, hydrate of magnesia, serpentine, chlorite, copper, octahedral crystals of oxyd of iron, chrome.

6. Granular Quartz.

MINERALS. Quartz, ferruginous quartz, hematitic iron ore, manganese, titanium.

7. Granular Limerock.

MINERALS. Limestone, mica, talc, purple tourmaline, asbestos, serpentine, verd antique, white pyroxene, grammatite, magnesian limestone, tremolite, dolomite, gibbsite, brucite, necronite, titanium, nephrite, chrome.

8. Sparry Limerock, (*or Second Primitive Limerock.*)

MINERALS. Limestone, calc spar, chlorite, lead, antimony.

* There is no distinct chlorite rock. Mica-slate, talcose-slate, argillite, graywacke, and slaty-limerock, are often coloured with chlorite.

9. Primitive Argillite.

Subdivisions. Shining Slate.
Chloritic Argillite.
Graphic Slate.
Alum Slate.

Minerals. Milky quartz, chlorite, red jasper, striped jasper, lydian stone, macle, plumbago, talc, manganese, copper.

II. TRANSITION CLASS.

10. Transition Argillite.

Subdivisions. Roof Slate.
Glazed Slate.
Alum Slate.

Subordinates. Flinty Slate.
Jaspery Slate.

Minerals. Alum, milky quartz, red jasper, green jaspery slate, lydian stone, anthracite, plumbago, mercury, lead, copper, manganese, petrifactions.

11. Calciferous Sandrock, (*or Transition Sandrock.*)

Minerals. Quartz, quartz crystals with two pyramids, calc spar, lamellar sulphate of barytes, carbonate of barytes, brown spar, anthracite, silver, mercury, lead, copper, zinc, antimony.

12. Metalliferous Limerock, (*or Transition Limerock.*)

Subdivisions. Compact Limerock.
Slaty Limerock.
Shell Limerock.

MINERALS. Limestone, quartz, petrifactions, silver, lead, copper, gold, mercury, zinc.

13. GRAYWACKE, (*or Metalliferous Graywacke.*)

Subdivisions. Slaty Graywacke.
Chloritic Graywacke.
Rubble Graywacke.
Red Wacke.

Subordinates. Grinstone Grit.
Hone Stone.

MINERALS. Quartz, calc spar, anthracite, petrifactions, carbonate of barytes, alum, chlorite, copper, lead, manganese, silver, gold, antimony.

14. OLD RED SANDSTONE.

MINERALS. Quartz, corallinites, iron, copper.

III. SECONDARY CLASS.

15. MILLSTONE GRIT.

Subordinate. Conglomerate.

MINERALS. Quartz, coal.

16. SALIFEROUS ROCK.

Subdivisions. Red Sandrock.
Red Slate.

Subordinates. Salt above—coal beneath?

MINERALS. Quartz, bones of quadrupeds, common salt, glauber salts, muriate of lime, muriate of magnesia, coal, mercury.

17. GREY BAND, (*or Grey Fake.*)

MINERALS. Quartz, salt.

*18. FERRIFEROUS SALTE.

Subordinates. Argillaceous Iron Ore.
Jaspery Iron Ore.

*19. FERRIFEROUS SANDROCK.

Subordinates. Argillaceous Iron Ore.
Jaspery Iron Ore.

MINERALS. Quartz, zinc.

*20. CALCIFEROUS SLATE, (*or Second Graywacke with Shell Limerock.*)

Subordinates. Shell Limerock.
Slaty Limerock.
Water or Silicious Limerock.
Gypsum.

MINERALS. Fibrous barytes, calc spar, satin spar, saltpetre, nitrate of lime, epsom salts, alum, copperas.

*21. GEODIFEROUS LIMEROCK, (*or Swine Stone.*)

MINERALS. Calc spar, fluor spar, corals, shells, sulphate of strontian, brown spar, snowy gypsum, selenite, zinc, antimony?

*22. CORNITIFEROUS LIMEROCK, (*or Second Shell Limerock.*)

Subordinate. Hornstone layers.

*23. PYRITIFEROUS ROCK, (*or Third Graywacke with Shell Limerock.*)

Subdivisions. Pyritiferous Slate Rock.
Pyritiferous Lime Rock.

Subordinate. Sulphurous and Bituminous Coal.

MINERALS. Concrete wacke, sulphuretted hydrogen, bitumen, coal, copperas, epsom salts, alum, iron pyrites, petrifactions.

IV. SUPERINCUMBENT CLASS.

24. AMYGDALOID, (*or Proper Basalt.*)

MINERALS. Hornblende, chalcedony, analcime, chabasie, stilbite, zeolite, agate, sardonix, calc spar, barytes, amathyst, carnelian, agate, opal, leucite, idocrase, prehnite, laumonite, copper.

25. GREENSTONE TRAP, (*or Newest Floetz Trap.*)

MINERALS. Hornblende, quartz, felspar, leucite, prehnite, augite, copper.

N. B. The names to which the asterisk (*) is prefixed, I propose for want of other appropriate names.*

* In the 2d Edition of my Index to the Geology of the Northern States, I followed those geologists who consider the secondary limestone and gypsum, as forming regular strata. I had then but little knowledge of the secondary rocks of our country, as I acknowledged in that treatise.

GENERAL DESCRIPTIONS

OF

North American Rocks.

I. PRIMITIVE CLASS,

Includes those rocks, which never contain any organic relics, nor coal.

1. Granite,

Is an irregular aggregate of quartz, felspar, and mica,* *not of a slaty structure.* It is called *grey* or *red*, according to the colour of the felspar. When the rock is chiefly felspar, with disseminated specks of quartz, so as to give the surface a little the appearance of Chinese letters, it is called *graphic.* Local-

* It is not necessary that one should be an adept in mineralogy before he enters upon the study of geology. But the student in geology must be able to recognize the nine minerals, which constitute what are called the letters of the geological alphabet, before he commences the study of rocks. Specimens of these minerals are easily obtained; and by trying their hardness with the knife, their lustre by the eye, and whether they will effervesce with nitric or muriatic acid, all necessary knowledge of them is soon acquired. They are Quartz, Felspar, Mica, Talc, Hornblende, Argillite, Limestone, Gypsum, Chlorite. Every rock consists essentially of one, two, or three of these nine homogeneous minerals. All other minerals embraced in rocks, may be considered as accidental; though their presence often furnishes good factitious characters. Werner's topaz rock would require another mineral; but that has only one known locality.

ITIES. Granite is often seen in veins traversing gneiss and hornblende rocks, as in Spencer and Belchertown. It presents itself in very thick alternating layers in gneiss also. Near the military academy, at West-Point, in the Highlands, such layers may be seen from ten to twenty feet in thickness. But from several re-examinations made within two or three years, I am inclined to doubt the existence of a stratum of granite in Spencer, Belchertown, Southampton, Chesterfield, or the Highlands. I venture to ask this question. Is granite to be found in New-England or in New-York, other than in veins, or alternating layers, (possibly in beds) embraced in other primitive rocks? Graphic granite is in considerable quantities in Southampton mines, twenty-five miles south of Conway; also in Litchfield county, in Connecticut.

2. GNEISS,*

Is a *slaty* aggregate of quartz, felspar and mica; generally finer grained than granite. When it is very fissile it is called *slaty* gneiss; when in compact blocks, it is called *quarry* gneiss; when it contains but little felspar or mica, and is chiefly made up of fine grains of quartz, it is called *sandy* gneiss; when it is spotted with large pieces of felspar, it is called *porphyritic* gneiss. LOCALITIES.† *Slaty*, in

* Doctr. De Witt Clinton, Prof. Nuttall, and many other learned geologists, consider this rock as a slaty, or stratified, variety of granite.

† The names of places referred to will be found on the profile map, or they will be referred to a place that is on it.

Spencer; *porphyritic*, in Coy's Hill; *sandy*, at Little Falls; *quarry*, between Leicester and Worcester, also in Haddam, Conn.

3. Hornblende Rock,

Is an aggregate of hornblende and felspar. It often contains grains of quartz, and sometimes a little mica. No other rock, in our district, excepting those of the superincumbent class, contains any material proportion of aggregated hornblende.—When it is irregularly aggregated, presenting the general aspect of granite with hornblende substituted for mica, it is *granitic hornblende* rock; when it appears like gneiss, with hornblende substituted for mica, it is *gneissoid hornblende* rock; when it is of a slaty structure, it is *slaty hornblende*; when it is spotted with pieces of felspar larger than those of the general aggregate, it is *porphyritic hornblende* rock; when it is an aggregate so constructed as to appear to be hornblende speckled with felspar, it is *sienite*. Localities.—The *granitic* variety in Dalton, three miles south of the village, and twenty miles south of Adams; *gneissoid*, the whole of Butter-Hill, in the Highlands, on the Hudson, one hundred miles south of Albany; *slaty*, in Belchertown, five miles southwest from the village; *porphyritic*, in the west part of Plainfield.

4. Mica-Slate,

Is an aggregate of mica and grains of quartz. It is generally in thin rifty layers, and very fissile. It is sometimes compact, and contains columns or piles of small six-sided crystals of mica, piercing

the layers. LOCALITIES.—*Fissile*, in Conway; *compact*, Worthington, ten miles southwesterly from Plainfield.

5. TALCOSE ROCK,

Is an aggregate of talc and fine grains of quartz, and generally some mica. It differs from mica slate in many localities, by containing very little talc in addition to the common constituents of mica slate. It is *talcose slate* when of a silver-grey colour; *chlorite slate*, when greenish; it passes into *steatite* when the talc is in large proportion. LOCALITIES.—*Talcose slate*, Plainfield; *steatite*, Cummington, ten miles south of Plainfield; *chlorite slate*, a few miles west of Plainfield.

6. GRANULAR QUARTZ,

Is made up of grains of quartz in a state of aggregation, without the appearance of any cement. When the whole mass has a tawney appearance, (which is the most common variety) it is the *yellow granular quartz*; when it is more fine-grained, somewhat compact and nearly white, it is the *white granular quartz*. LOCALITIES.—Near Williams College is the *yellow*; in Wallingford, Vermont, sixty miles north of Williams College, is a mountain of the *white*.

7. GRANULAR LIMEROCK,

Is made up of glimmering grains of limestone, without the appearance of any cement. It is generally more or less translucent at thin edges, and white. When it is in thick compact layers or

masses, it may be wrought, and is called *statuary marble*; when it is rifty or divided into thin layers, often with talcose slate intervening, it is *slaty limerock*. LOCALITIES.—*Statuary marble*, at Adams, and Williams College, and extending a great distance north and south; *slaty*, accompanying the statuary; but most abundant in Alford, forty miles south of Williams College.

8. SPARRY LIMEROCK, (*or Second Primitive Limerock*,)

Is somewhat granular, but much less so than the granular limerock; its grains being finer and more closely compacted. It is distinguished from all other limerocks by being traversed at greater or less intervals by veins of *calcareous spar*. These veins often cut the rock into small checks. It embraces no petrifactions. It generally contains quartzose grains, so that its surface becomes sandy on exposure. Its colours are variegated; blue, white, grey, greenish, &c. It alternates with primitive argillite. LOCALITIES.—At the east foot of Williamstown mountain; also on the west side, along the Little Hoosick.

9. PRIMITIVE ARGILLITE,

Is a slaty homogeneous rock, which dissolves into a clay soil on exposure; therefore often called clay-slate. Its slaty layers approach a vertical position in our district, always leaning in a direction opposite to the primitive range of rocks with which it is connected. Its common colour is bluish, often inclining to purple. Its layers or tables are often undulated, and covered with a talcose coat, giving

them a shining surface. Sometimes this rock is coloured green with chlorite; sometimes it is red; in some places it contains so much plumbago, that it will give a black streak to paper; it is then called *graphic slate*; sometimes it passes into *alum slate*. Localities.—Williamstown Mountain, Connecticut river.

II. TRANSITION CLASS,

Includes those rocks, which, in some localities, are known to contain anthracite coal, or marine organic relics; but never contain bituminous coal, nor dry land or fresh water petrifactions.

10. Transition Argillite,

Is a soft slaty homogeneous rock, mostly of a bluish or dark brown colour. It dissolves into a clay soil more readily than primitive argillite. Its slaty layers are generally more nearly in a vertical position than those of the primitive. It is not so shining or variegated, being more uniform in its colours. It frequently contains anthracite; and sometimes, though rarely, petrifactions are found in it. Localities.—In the next ridge west of Williamstown Mountain, Mount Olympus, the banks of the Hudson, and Cahoes Falls. It is separated from primitive argillite every where in our district by sparry limerock.

11. Calciferous Sandrock, (*or Transition Sandrock,*)

Is an aggregateof quartzose, sand and fine grains of carbonate of lime. The proportions of the con-

stituents are variable; but the quartz is generally in the largest proportion. On exposure, the limestone part soon disappears, leaving the surface a mere silicious sandstone. It abounds in geodes, often lined with quartz crystals, &c. It may be truly called a *geodiferous sandrock*. Localities.—A mile northeast from Mount Olympus; Barnagat, on the Hudson; Flint-Hill; inclining against both sides of the gneiss rock of the Noses and Little Falls.

12. Metalliferous Limerock,

Is more or less compact, opake, fracture conchoidal and scaly. It is frequently cellular, containing small disseminated masses of calcareous spar in scales. It is sometimes slaty; but then each lamina or layer is compact. It is not traversed by veins of calcareous spar, like sparry limerocks. A kind of bark-like ferruginous slate is often interposed in the natural cleavages. Its upper surface often contains petrifactions. Colour generally grey or slate-colour. Localities.—Accompanies and reposes on the calciferous sandrock every where in our district. It is a very important rock in some countries. The silver mines of South America are said to be in this rock.

13. Graywacke,

Is an aggregate of angular grains of quartzose sand, cemented by indurated clay, apparently composed of disintegrated argillite. It generally contains glimmering scales of talc and mica. A coarse variety, called *rubble-stone*, (or common gray-

wacke) is very hard, and contains large pebbles and fragments of argillite, slaty graywacke, &c. Glimmering scales are rare or wholly wanting in this variety. The colour of this rock is generally grey. But it is coloured green with chlorite in Petersburgh, and red with the peroxyd of iron near the foot of Catskill Mountain. Localities.—This is a very extensive rock in the state of New-York, Pennsylvania, &c. It constitutes most of the Catskill and Allegany mountains. On our section, all the varieties may be obtained, excepting the red, at Petersburgh and Alexander's bridge.

14. Old Red Sandstone,

Is an aggregate of angular grains of quartzose sand, cemented together by a ferruginous argillaceous cement. Though it is coloured red, or reddish, if it be pulverized and thoroughly washed, most of the quartz grains appear glassy and nearly transparent. Some of the grains, however, appear to be about the colour of rose quartz. It generally contains glimmering scales, like graywacke slate; but the interstices between the grains of quartz are not filled like those of graywacke. Localities.—Connecticut River presents the only locality in our section. But it is very abundant near the top of Catskill Mountain, about forty miles south of Schenectady. It contains petrifactions of branching corallines, resembling the roots of woody plants. These petrifactions, being mistaken for dry land plants, have caused this rock to be placed in the secondary class. I have traced a single branch of this petrifaction more than thirty feet in this rock.

One mile south of Pine Orchard, on Catskill Mountain, this petrifaction is very abundant in this rock.

III. SECONDARY CLASS,

Includes those rocks which sometimes contain bituminous coal, or fresh water, or dry land relics, as well as those of marine origin. Some specimens in every secondary stratum in our district, will effervesce with acids.

15. Millstone Grit,

Is a coarse harsh aggregate of quartzose sand and pebbles: apparently held together by the attraction of adhesion, without cement. It is grey, or yellowish grey, sometimes reddish. It has a very sharp grit, which serves well for millstones. Localities.—In the side of the hill from two miles southwest of Little Falls to Utica, particularly at the top of the falls in Starch-Factory Creek, and at the factory on Steel's Creek; in Westmoreland; in Lower Genesee Falls.

16. Saliferous Rock,

Is an aggregate of minute rounded grains of quartzose sand, or of minute argillaceous and quartzose grains, formed into red or greenish sandstone, or soft red or greenish brittle clay slate. The sandstone kind is distinguished from the old red sandstone, by its rounded grains, as they appear under the magnifier, and by its not containing glimmering scales, excepting in a few rare cases. Localities.—In the side-hill along the south side

of the canal, from near the Little Falls to Utica; at Vernon; Oneida Creek; Lenox; Salina; four miles west of Rochester to Lockport; Lewiston, ten miles north of Tonawanta.

17. Grey Band, (*or Grey Feke,*)

Is a hard fine-grained grey rock, which is so compact that it may be considered as homogeneous. It is a thin but continuous stratum, every where overlaying the red saliferous rock; and might be called *grey saliferous rock.* Localities.—Along the south line of the canal, in the side of the hill, from near Little Falls to Utica; Westmoreland; Verona; Genesee Falls; Lewiston.

18. Ferriferous Slate,

Is a soft argillaceous, almost homogeneous rock. It is greenish blue and bluish green. It is a very brittle slate, generally scaly or shelly. It is every where immediately beneath red argillaceous iron ore, or embraces it in alternating layers. Localities.—In the hill, south of the canal, from Little Falls to Utica; Verona mines; Genesee Falls; Niagara.

19. Ferriferous Sandrock,

Is a grey, or yellowish grey, massive aggregate of quartzose grains, often hyaline, held together apparently by the attraction of adhesion. It embraces and overlays red argillaceous iron ore, and is frequently coloured with it. Localities.—On the highest hills from near Little Falls to Oneida Creek, overlaying and embracing the most valuable iron

mines of Westmoreland, Verona, Vernon, Paris, &c. In the bed of the canal it appears frequently from a little west of Rome to Montezuma; in Genesee Falls; Niagara.

20. Calciferous Slate, (*or Second Graywacke, with Shell Limerock, &c.*)

Is an aggregate of quartzose sand and clay slate, or other alluminous compounds. Sometimes it is a soft thin slate; but it is often hard, silicious, and rings more or less on being struck. It is a grey colour, and can scarcely be distinguished from graywacke slate in hand specimens, with the naked eye. But under the magnifier the constituent particles appear somewhat rounded; and it is nearly or quite destitute of the shining scales. Localities.—The principal rock forming the ridge south of the canal from Oneida Creek to Pittsford. It embraces all the plaster beds, water-lime beds, shell limestone beds, &c. throughout its whole extent.

21. Geodiferous Limerock,

Is an amorphous irregular limerock, which abounds in geodes. It is generally fetid on being struck; is often very dark-coloured, but sometimes light grey. It contains, in geodes, calc spar, zinc blende, fluor spar, sulphate of barytes, &c. Localities.—The banks and bed of the canal near the east side of Genesee River; Lockport; Niagara Falls.

22. Cornitiferous Limerock,

Is made up of shell limestone layers, embracing

layers and beds of hornstone. It seems to be the most extensively continuous shell-limerock in our district. LOCALITIES.—Black Rock; Niagara River.

23. PYRITIFEROUS ROCK, (*or Third Graywacke, with Shell-Limerock,*)

Is a silicious or calcareous grey rock with alluminous cement, either slaty or in blocks, and abounding in iron pyrites. It is called pyritous shale by some geologists. On exposure it is rapidly disintegrated. It abounds in petrifactions, which sometimes consist of iron pyrites. LOCALITIES.—South end of Cayuga Lake at Ithaca; south shore of Lake Erie, between its eastern termination and Sturgeon Point.

IV. SUPERINCUMBENT CLASS.

Includes those hornblende rocks, which overlay other rocks in a non-conformable position. They generally repose on old red sandstone, or on saliferous rock in our district. They are considered by many distinguished geologists, as of volcanic origin. See the learned and most instructive essay of Prof. Cooper, LL. D. in Amer. Jour. Sci. Vol. I.

24. AMYGDALOID, (*or Basalt,*)

Is an aggregate of hornblende particles, so very minute and so closely compacted, as to appear homogeneous to the naked eye. Under the magnifier minute particles of felspar, and a little quartz, may be discovered in some specimens. It is dark

grey and brown, rarely greenish. It contains vermicular cavities, and sometimes geodes, filled with calc spar, hyacinth quartz, chalcedony, &c. These substances often fall out on exposure. Localities. —Under Mount Holyoke; under the Palisadoes on Hudson River.

25. Greenstone Trap,

Is an aggregate of grains of hornblende and felspar, sometimes containing quartzose sand. It generally exhibits a prismatic or columnar tendency; and is often in very perfect polyhedral columns. It rings on being struck, which gives it the name of clinkstone. Its colour is mostly dark grey, with a greenish tinge on being wet. It is coarser-grained than amygdaloid, which it always overlays in our district. Localities.—Mount Holyoke; the Palisadoes on the Hudson River.

EXPLANATIONS

OF A FEW TECHNICAL TERMS, USED IN THE FOLLOWING DESCRIPTIONS.

Stratum.—The misapplication of this term calls for a particular explanation. It is properly applied to any individual in a series of rocks, when we speak in relation to the series. It may also be applied to an individual layer of a rock, or of an alluvial bank, when we speak in relation to that rock or bank only. Thus, when we speak of the general structure of the earth, we say it is made up of many strata; some of which are granular and

others are stratified. As granite is not generally stratified, but graywacke slate is. I use the word layer, however, in all cases, excepting when I intend an entire rock in the general series. For although either stratum or layer may be used here with propriety, I can avoid much repetition and circumlocution, by this distinction.

Alternating Layers.—This expression is used, when a rock embraces layers of a different rock, apparently co-extensive with itself, with which it is arranged in interchanging series.

Bed.—This term is used, when a rock embraces a different rock, or mineral which is not one of its essential constituents, of limited extent, between layers which terminate it by approximation, and finally contact with each other.

Disseminated.—This term is used, when a mineral is scattered about in a rock of which it is not an essential constituent, in small pieces.

Vein.—This term is applied, when one kind of rock traverses another across its grains, laminae, or fibres. Any mineral may be in veins.

Geode.—This term is applied, when a rock contains a cavity more or less spherical, or some of its sides curvilinear. It is sometimes empty; but more commonly it is lined with crystals, or contains a substance different from its rock.

GENERAL FORMATIONS.

Primitive, Transition, Secondary, and Superincumbent.

[Vid. Def. pp. 27, 32, 35, 38.]

The Erie Canal crosses primitive, transition, and secondary rocks. From its commencement at Albany, to Rome, a distance of about one hundred and forty miles, it passes over primitive and transition rocks only. From near Rome to its termination at Lake Erie, a distance of about two hundred and twenty miles, it passes through a country which is uninterruptedly secondary. From Albany to Rome, the line of the canal is wholly confined to the transition formation; excepting about two or three miles along the foot of the Noses, in the town of Root, and about the same distance where the canal ascends the Little Falls.

Though three formations present characters most unequivocal, according to the definitions given at pages 27, 32, and 35, a single stratum only of the primitive class is crossed by the canal. All the strata belonging to the transition class, excepting the Old Red Sandstone, are cut through by it; also all the secondary are either cut through by it, or underlay it beneath the alluvial deposits. No superincumbent rocks are found in place within the limits of the canal district.

Most of New-England is primitive. Connecticut River runs through a transition and secondary valley, while crossing Massachusetts and most of Connecticut. A similar formation extends down to New-Haven, diverging from its west side near Middletown. There is a transition strip from Boston to Newport, R. I.—also a small patch about Worcester, Mass. &c. The west side of Vermont, adjoining Lake Champlain, is mostly transition also. With these and a few other exceptions of little extent, all the New-England states are founded on primitive rocks.

The primitive rocks of New-England are naturally divided into two distinct ranges, which may be called the White Mountain and Green Mountain ranges. The White Mountain range runs down from Lower Canada, on the east side of Connecticut River, to the Sound. It runs through New-Hampshire, including the White Mountains, and crosses our profile section in the town of Spencer. The Green Mountain range runs down on the west side of Connecticut River and east of Lake Champlain, and of the northern part of the Hudson River. It crosses our section in Savoy, and continues in a south direction to near the northwest corner of Connecticut. There it divides into two branches. One branch inclines westerly and forms the Highlands, which cross the Hudson about fifty miles from its mouth. The other branch continues down to the Sound, embracing most of Long-Island, New-York Island, Staten-Island, &c.

The state of New-York is divided into nearly equal parts of primitive, transition, and secondary;

if we admit of a stratum of primitive argillite. The primitive is divided into the northern and southern by the interposition of the transition. The southern primitive district is separated from the transition by a line commencing near the northwest corner of Bennington county, in Vermont, and running nearly parallel to the east line of this state, at the distance of from three to ten miles west of it, as far as the north line of Dutchess county. It then runs in a southwesterly direction through Newburgh, Goshen, &c. to the state of Delaware. The northern primitive district lies west of Lake Champlain, and east and southeast from Lake Ontario and the River St. Lawrence. It consists of mountain ridges of gneiss, with intervening valleys of transition sandstone and limestone. The gneiss is more nearly in a horizontal position, than is usual for rocks of gneiss in New-England. All these mountain ridges may be called by the general name, Macomb's Mountains.* They are bounded on the east by Lake Champlain, and the flat country east of Palmertown Mountain; on the north, northwest and west, by a border of transition rocks, interposed between them and the St. Lawrence and Lake Ontario; on the south by a similar border, accommodating itself to their spurs and undulations in the vicinity of the Mohawk, Fish Creek and Salmon River.

If a line be drawn from the southeast corner of Lake Ontario, so as to run about three miles south-

* First, because they are mostly embraced in Macomb's Purchase.—Secondly, because Gen. Macomb signalized himself at the margin of this district, in the late war.—Thirdly, because they have never been known by any general name.

westerly from Salmon River, the west branch of Fish Creek, and the Mohawk as far as Little Falls; then south about nine or ten miles; then west to the town of Pompey; then southwest to the Pennsylvania line, where it crosses Tioga River; this will form the division line, or very nearly, between the transition and secondary formations of the state of New-York. The *transition rocks*, south of the Mohawk, are chiefly argillite and graywacke.—Those which are north of the Mohawk, are mostly sandstone and limestone. The *secondary rocks* are mostly of a slaty texture, embracing limestone in beds; excepting the northern part in the vicinity of the canal line and Lake Ontario. Here the rocks are chiefly of a sandy or very soft argillaceous texture.

Both the transition and secondary formations, which seem to belong to the Green Mountain series, differ widely in all their most striking features, from those of the Macomb Mountain series. From the latter proceed the iron, salt and coal formations. Even the mountain ridges themselves abound in the primitive ores; especially in the vicinity of Lake Champlain and Lake George.—Whereas the Catskill Mountains and their subsiding ridges, which manifestly appertain to the Green Mountain range, are very barren in useful minerals. The secondary rocks too, which proceed from them, have not hitherto presented much to interest the mineralogist or the miner.

The order of strata is uniform in our district, both in the Green Mountain and Macomb Mountain series. But strata are often wanting here, as

in all other countries. It is a remarkable fact, that most of the secondary strata are wanting in the Green Mountain series; and most of the primitive and transition strata are wanting in the Macomb Mountain series.

Several geologists have told us, that the subsiding ridges of the Alleghany and Catskill chain of mountains extend up the west side of Lake Champlain into Canada. McClure, however, asserted that the northern counties, embracing Macomb's Mountains, were primitive. I venture to add, that the Catskill Mountain graywacke does not cross the Mohawk any where west of Schoharie Kill. Its breadth is probably one hundred and fifty miles from east to west as high north as the latitude of Schenectady, or a few miles higher. It is there contracted to about thirty miles, and continues narrowing as it passes up in a northeasterly direction into Saratoga county, at a considerable distance southeasterly from the lower spurs of Macomb's Mountains.

There are no rocks of the superincumbent class in the state of New-York. The well known natural Palisadoes, on the banks of the Hudson, are on the New-Jersey shore. Mount Holyoke, in our section, on Connecticut River, is an interesting locality. These rocks have been described by Mr. Hitchcock, in Silliman's Journal, and by myself in the Index to the Geology of the Northern States. Further observations on them will be made farther on.

DESCRIPTION OF ROCKS,

In the Vicinity of the Erie Canal.

REMARKS.

I venture to assert that it is not more difficult to communicate a knowledge of the geography of a country without a map, than a *general view* of the geology of it without a profile or transverse section of the strata. A birdseye view, or map presenting the geographical geology, is highly useful for particular local reference. But we can never acquire a knowledge of the geology of an extensive district, nor, in truth, of a single perch, from such a map; because the author cannot present his own views of his subject in this manner. Every American geologist sets a high value on Mr. Hitchcock's geological map of the district adjoining Connecticut River, published in Silliman's Journal. But he acquires more knowledge of the geology of that district by inspecting the same author's profile of the rocks one hour, than by studying his map and descriptions a full month.

The Geological Profile, connected with this report, must be carefully examined by those who wish to understand the following descriptions. It has been drawn up with as much accuracy as I was capable of doing it. It is supposed to embrace a

breadth of about twenty miles. Or, in other words, I am not to be charged with mistakes, whenever I can find the rock laid down, any where within the belt of ten miles on each side of the canal, or on each side of a centre line drawn from the Delta of the Mohawk to Boston.

From Utica to Oneida Creek the canal runs in a semicircular bow; passing around by the village of Rome, several miles north of a straight line. Throughout the whole of this curve it passes through deep alluvion, where there is not a rock in place to be seen. I have continued the section across Westmoreland, Paris, Vernon, &c. in order to exhibit the iron formation, and the out-croppings of the most interesting secondary rocks.

In giving a description of the rocks of the canal district, I shall often be compelled to transcend those limits just prescribed, to give a correct view of the rocks within them. I was often compelled to travel to the distance of fifty miles from the canal, to obtain a knowledge of rocks which approach or cross it. I shall often refer to the rocks of Massachusetts in our section; and occasionally to those of other states, for the purpose of illustration.

The places set down in the profile plate, will be referred to without any description, however obscure they may be. Other places, of much greater importance, will be referred to them. This measure will save turning to gazetteers and geographical maps.

I shall describe the rocks according to the order in which their names are set down in the Nomenclature. Short descriptions only will be given of

those primitive rocks,* which do not present themselves within the canal district, or within ten miles of the canal.

* Readers who may have any curiosity to understand my views of primitive rocks, either for the purpose of controverting my opinions, or examining my collection of facts, are referred to the 2d Ed. of the Index to the Geology of the Northern States. I have not changed my opinions materially respecting primitive rocks, since that edition was published, excepting the cases expressed in this report.

PRIMITIVE CLASS.

[Vid. Def. p. 27.]

1. Granite. [Vid. Def. p. 27.]

This rock does not exist as a distinct stratum nearer to the canal than Saratoga, about eighteen miles north from Alexander's Bridge. In truth, I am inclined to doubt the existence of a distinct stratum of granite in New-England or New-York. That rock which presents itself near the base of the east face of Palmertown Mountain, a few miles north of Saratoga Springs, has higher claims to the character of a distinct stratum, than any granitic rock which I have seen in the Northern States.

Granite is found in veins, and in thin layers, occasionally, in all the southern spurs of gneiss which approach the canal from Macomb's Mountains. Clip Hill, in Johnstown, seven miles north of the Noses, in the same ridge, is a very perfect locality of gneiss passing into granite. Though it is a kind of graphic gneiss, because it is of a slaty structure, Doct. Clinton, Prof. Nuttall, and others, who are not willing to admit of any definite line of distinction between granite and gneiss, would call this rock *stratified graphic granite.* At Little Falls and the Noses, specimens of perfect granite are some-

times found, though rarely, embraced in gneiss. It may strictly be said by those who make distinct strata of granite and gneiss, that no granitic stratum comes within ten miles of the Erie Canal, at any place throughout its whole extent.

Granite is slowly disintegrated, forming a silicious soil, which is not very productive if unmixed. We have very little soil which is purely granitic; though the potash part of its felspar hastens its decomposition.

2. Gneiss. [Vid. Def. p. 28.]

This rock crosses the canal in the town of Root, forming the two prominences, called the Great and Little Noses; and at the Little Falls, forming the most prominent part of Fall-Hill. These prominences are ridges or spurs, extending down from Macomb's Mountains, of the northern counties.—They are about twenty-six miles apart where they cross the canal; and are here cut down to their bases by the bed of the Mohawk, leaving their detached points in view but about two or three miles, to where they pass under other rocks.

I examined the ridge which forms the Noses, to the distance of about twenty-five miles; pursuing it in a northeasterly direction along the western side of the Sacondago branch of the Hudson, after crossing it a little above the Fish-House. The Little Falls ridge I traced to a distance sufficient to ascertain, that the two ridges agree in all their important characters.

Like all the southern spurs of Macomb's Mountains, these ridges are chiefly made up of gneiss

rock, whose layers are frequently almost horizontal, being rarely much inclined. It seems to be what Cleaveland calls, "the more recent variety;" and often contains but little felspar or mica. Sometimes it passes into an almost pure quartzose sandstone, and frequently passes gradually into silicious limestone. The Kayaderosseras ridge embraces a layer of puddingstone or conglomerate, near Hadley's Falls, consisting of transparent quartz pebbles with a carbonate of lime cement.

In some parts of each range, often in contact with rocks of the character before described, we find those appearances which are common to the oldest gneiss rocks of New-England. In the town of Edinburgh, about thirty miles north from Schenectady, the gneiss is made up of coarse grains of quartz, felspar and mica, and its layers are almost as highly inclined as those of the gneiss of New-England. Iteven passes into pretty well characterized granite, in the same continuous stratum.

The gneiss rocks which are seen from the canal boats, while passing the Noses and Little Falls, present a red and orange tinge. This is caused by the decomposition of iron pyrites on the exposed surfaces; and the production of sulphate of iron. A fresh fracture will prove, that this is not the natural colour of the rock.

These rocks generally consist of large square and oblong blocks, set in layers of great extent.—Slaty layers are frequently interposed, however, which have the appearance of mica-slate. Many of these blocks are broken off and widely scattered over the adjoining country. Near Palatine

meeting-house, where the soil is thinly spread over the metalliferous limerock, these blocks or boulders almost hide the face of the fields. But they are concealed by the deep alluvion in the low intervals.

I found but few minerals embraced in the gneiss rocks of this district. Iron pyrites is very common in it every where. Petrosilex is found in a few places, both at Little Falls and the Noses, similar to that variety found by Mr. Brace in Litchfield, Conn. At Clip Hill, which was mentioned under granite head, there is an abundance of the most beautiful porphyritic and graphic gneiss. The slaty and block varieties are found half a mile farther west; also a mile west of East-Canada Creek, seven miles from its mouth. This last is the Little Falls range. I saw scales of plumbago in the gneiss of Clip Hill, that of Little Falls range, and of an intermediate spur, which terminates four or five miles north of the canal. The vast quantities of iron ore, plumbago, &c. embraced in this rock, near Lake George, sixty or seventy miles northeasterly from Little Falls, have been sufficiently described by Gibbs, Cleaveland, and others.

The oldest gneiss is not subject to hasty disintegration. Besides being a pretty hard rock, it is defended from the operation of the disintegrating agents by the highly inclined position of its layers, whereby their edges only are exposed. But the more horizontal and sandy variety, such as the southern spurs of Macomb's Mountains, is rapidly disintegrated. It forms a meagre loose sandy soil, such as the sand plains near Albany. Mixed

with adhesive clay soils, it is highly useful in keeping it duly open and loose.

3. Hornblende Rock. [Vid. Def. p. 29.]

On the southeast side of the mountain of Edinburgh, near the Fish-House, mentioned under the gneiss head, is a regular stratum of this rock inclining against the gneiss. It is pretty extensive; presenting the gneisseoid, slaty, porphyritic and sienitic varieties, in the same continuous stratum. I did not see any of the granitic variety in that immediate vicinity; but it is very common in some parts of the same mountain. This locality being between twenty and thirty miles north of the canal, I was desirous to find a nearer one. I saw very large boulders, some twenty feet in diameter, in Broadalbin, ten miles north of Flint Hill; also along the gneiss ridges all the way down to the canal. But I found no hornblende rock in place, excepting on the east side of the gneiss of Little Falls ridge, about seven miles north of the canal, and one mile west of East-Canada Creek. Here it is mostly concealed by the alluvial deposits, as well as the gneiss.

This rock is subdivided into several strata by most geologists.* But I have frequently seen every variety in the same naked individual stratum, in numerous localities in New-England. Therefore I cannot consistently adopt those subdivisions. In the gneisseoid variety, which constitutes Butterhill in the Highlands on the Hudson, every variety

* See Differences in Geological Nomenclature, farther on.

is embraced, particularly on the side of the hill towards West-Point. Every variety may be found in our profile section between Boston and Worcester; often in the same individual rock of but a few rods in extent.

Though I am convinced, after much examination, that there is but one stratum of primitive hornblende rock in the northern states, I am happy to be able to present the reader with a profile view of this rock, constructed upon the subdivision method. That part of the Rev. E. Hitchcock's profile view of the rocks of Massachusetts, from Marlborough to Waltham inclusive, is an excellent exhibition of that method. It comprehends the same district of country, which is marked as a single hornblende stratum in the general transverse section from the Atlantic to Lake Erie.

I agree with Mr. Hitchcock so far as this: That those varieties predominate, where he has marked them; and that one variety predominates over all the others in most localities. For example, the gneissoid variety predominates in the Highlands; and the granitic variety in Dalton, three miles south of the stage road, and twenty miles south of Adams, Mass. But as all the varieties are often found in the very *same individual layer* of the same rock, I think the rule which separates these varieties into strata, may with as great propriety subdivide granite into at least three strata, and graywacke into four.

Hornblende rocks are subject to moderate disintegration. They form a rich and durable soil; such as in Belchertown, Mass.

4. Mica-Slate. [Vid. Def. p. 29.]

This rock is not in place within the canal district. I saw several loose masses, which would agree with the definition, in various places along the spurs of gneiss which cross the canal. But gneiss often passes into a similar variety. A few miles westerly from Saratoga Springs, about sixteen miles north of Alexander's Bridge, at the extreme termination of the Palmertown spur of Macomb's Mountains, there is a coarse variety of this rock in the bank of a creek. This locality is nearer to the canal, than any other which has come to my knowledge.

Mica-slate is subject to rapid disintegration. It forms a glimmering loose meagre soil, requiring an admixture of argillaceous matter, to render it productive.

5. Talcose Rock. [Vid. Def. p. 30.]

Like the mica-slate, this rock is not in place within the canal district. It is of great extent north and south, where it crosses our section; at least two hundred miles. The nearest locality yet discovered, was shewn me by Dr. J. H. Steel, about six miles north of Saratoga Springs, and twenty-four miles north of Alexander's Bridge, in the Palmertown spur of Macomb's Mountains. Here it passes into steatite.

Talcose rock resembles mica-slate in its disintegration, and in the production of soil; excepting that it becomes more saponaceous in rainy weather.

6. Granular Quartz. [Vid. Def. p. 30.]

This stratum does not approach the canal any where nearer than Adams, and Williams College,

as set down on our geological profile. There it extends north and south more than three hundred miles. It seems to continue unbroken from Lower Canada through Vermont, Massachusetts, and a part of the state of New-York. In Dalton, Mass. about twenty-three miles south of Adams, it appears as if it had been broken into angular fragments from the size of a pea to that of a hogshead, and then joined together by a thick paste of hematitic iron ore, often stalactitic. It is generally opaque, and of a yellowish hue; but in Wallingford, Ver. it passes into a white semi-translucent rock. Opposite the lands of Mr. Isaac Munson, it becomes a snow-white rock of mountain height, and two or three miles in length. On my describing this mountain to an experienced glass manufacturer, he said the rock might be pulverized very cheaply by calcination, and become an excellent material for the manufacture of flint glass.

Granular quartz is but slowly disintegrated, therefore its rounded boulders are very numerous in its vicinity. The soil which it produces, is of course a silicious sand.

7. Granular Limerock. [Vid. Def. p. 30.]

This rock is co-extensive with the granular quartz, and approaches the canal but little nearer. It crosses our section with it, and often alternates with it. Prof. Dewey says, it alternates with mica-slate and gneiss in the valley north of Saddle Mountain.* In many places where it stretches

* See Amer. Jour. Science, Vol. I. p. 337—346.

along through Vermont, Massachusetts, Connecticut and New-York, it furnishes the true statuary marble. It is extensively known by the name of Stockbridge marble, because it was first wrought in Stockbridge, Mass.

Its primitive character is manifested by the talco-micaceous slate which frequently occurs in thin layers in its natural cleavages. I do not know that it contains any ores, excepting iron pyrites, titanium and chrome. A few rare specimens of reddish tourmaline have been found in it. It sometimes contains serpentine, tremolite, grammatite, pyroxene and asbestos. Sometimes it passes into dolomite, and often into silicious limestone, by combining with its neighbour, granular quartz.

Granular limestone is subject to chemical decomposition, as well as ordinary disintegration. Therefore deep valleys are formed along such ranges. It makes a rich soil in combination; consequently these valleys are excellent land.

8. Sparry Limerock, (*or Second Primitive Limerock.*) [Vid Def. p. 31.]

This rock differs so widely from granular limestone, and being in the vicinity of that rock, all geologists treat it as a different stratum. At New-Lebanon Springs, twenty miles south of Williams College, it has been examined and described by the principal geologists of our country, and compared with the granular limestone of Pittsfield, seven miles east of it. Its variegated colours, which, when wrought, give it the name of clouded marble, its peculiar veins of calcareous spar, and

its finer grains, serve to give it very distinctive characteristics. It has generally been called transition limestone, though its leading characteristics are wholly wanting in the European descriptions of that rock. As some of its characters agree, our unwillingness to introduce new names has caused it to be called transition or metalliferous limestone, in all the descriptions of it which have been published.

Those geologists who call this a transition rock, mostly consider Williamstown Mountain range as primitive argillite. This rock is found geologically lower, as well as higher than that rock. It is not a mere alternating bed; but is as well characterized one hundred and fifty miles at least north and south; besides, it never embraces any petrifactions. When I was led to join this rock to a limerock which runs parallel to it several miles farther west, I viewed it as decidedly transition, because that rock contains petrifactions. But I have now ascertained that these two limerocks are severed by intervening strata more than one hundred miles, and I have no reason to believe they ever come in contact.

These are my principal reasons, now, for placing this rock in the primitive class. As we have no name for it, I call it sparry limerock; which may be considered as a part of its description, when a name shall be established by competent authority.

This rock is often found in compact uninterrupted layers for many yards; then it is cut off by broad veins of white and pearly calcareous spar. A most remarkable vein of great extent traverses it

in Bennington, twelve miles north of Williams College. The spar is dug out, and used as a flux in the iron furnace of Seth Hunt, Esq. In some places it may be wrought into beautiful clouded marble, between the veins of spar; but it is often cut up into very small blocks by these veins, not exceeding five or six inches in extent. Between Williams College and Bennington it is very soft, and has much the appearance of Nova-Scotia gypsum. In the time of our last war with England, when the importation of gypsum was interrupted, and we had no canal to facilitate the transportation of our western gypsum, a company of jockies sold many tons of this rock to the farmers for gypsum.

In some places it is slaty, when it bears considerable resemblance to the true transition limestone. About three miles south of New-Lebanon Springs, on the Union Turnpike, is a locality of the slaty variety, in which the layers are cut into parallelograms by the calc spar. It is often slaty, or more properly stratified, along the Little Hoosick, on the west side of Williamstown Mountain.

One remarkable fact ought not to be overlooked, which perhaps has no connection with this rock. There are two localities in the Little Hoosick range of this rock, from which issue vast quantities of nitrogen gas. One of these localities is at the well known springs of New-Lebanon. The other is in the southeast corner of the town of Hoosick, on the farm of John Bratt, ten miles northwest from Williams College. The ascent of gas is rendered visible by the water which stands over the places where it issues; but it seems to have no connexion

with the water. It probably issues directly from this rock; but whether produced in the rock, or whether it merely passes through its fissures, is not determined. See the account of this gas, made by Dr. L. C. Beck and myself, in Mr. Van Rensselaer's survey of Rensselaer county, p. 29.

This rock, like all limerocks, is subject to a double course of decomposition, and makes excellent soil when compounded with clay. All limerocks are acted upon by the common disintegrating agents, water and change of temperature. In addition to this, it is well known that carbonic acid holds its base, the lime, with a tenure more feeble than that of any of the common acids. Consequently if muriatic, sulphuric, or nitric acid comes in contact with limestone, it is immediately decomposed. We have vast quantities of muriate of lime in our wells, springs, &c. which is a very soluble salt. If nature has now, or formerly had, any method for presenting large quantities of muriatic acid to the limerocks, they would of course be reduced to that soluble salt with great rapidity. Limerocks would be rapidly dissolved, leaving valleys between those rocks which are subject to the ordinary disintegrating agents only. The valleys of Adams, Williamstown, Little Hoosick, &c. which are situated on limestone, could then be satisfactorily explained. If the common opinion, that the ocean has stood over our continent, be received as true, we have only to add one more conjecture to make out the requisite supply of muriatic acid; that is, we must suppose that the ocean at that time contained an excess of that acid.

If we were permitted to assume as true the existence of the requisite quantity of free muriatic acid, we could make out a very convenient theory for explaining many phenomena. We should then know where to look for our present vast supply of muriate of lime, which gives what we call hardness to our spring waters in clay soil. We should say, that clay bottoms being impervious, the long formed muriate of lime was still retained by them. We should then be enabled to account for the vast quantities of carbonic acid with which our Saratoga, Ballston, and other springs, are supplied.

I confess I have run too far with this subject; particularly as this rock does not approach the canal nearer than Little Hoosick, a distance of about eighteen miles. If these suggestions are of any value, however, they have an equal application to all the limerocks of our district. The reader is not to understand that these suggestions are given as original, any farther than as it respects their local application.

9. PRIMITIVE ARGILLITE. [Vid. Def. p. 31.]

I was long a follower of Bakewell, in placing all argillite in the transition class. Certainly much may be said in favour of his views on that subject. But after six years examination, made along more than two hundred miles of the range which crosses our section west of Williams College, assisted by many of my pupils, I have discovered in it neither petrifactions nor anthracite coal. In addition to this, the locality in Columbia county, where I supposed a connexion could be traced between this

range and that which is decidedly transition, I find is interrupted by a narrow continuation of the western range of sparry limerock.

Though I have yielded to the high authority of a Silliman, a Gibbs, &c. in placing this rock in the primitive class,* I still do assert, that many extensive localities of that rock, which all those geologists acknowledge to be transition, afford most perfect specimens of shining argillite The veins of quartz, too, in which this primitive argillite abounds, is the milky variety, and perfectly opaque. It may be observed, however, that the talcose rock often contains veins of milky quartz; though it is sometimes translucent—particularly in Taghconnuc Mountain, about forty-five miles south of Williams College.

It is stated in Rees' Cyclopedia, that all argillite, or roof slate, has its slaty laminæ standing at an angle of 50 or 60 degrees with the general direction of the stratum. Both the primitive and transition argillite of our district, west of the Green Mountain range of gneiss, have the laminæ standing at an angle not greatly differing from this statement. They approach the horizontal position, however, as the rock approaches the other primitive strata. This rock is not stratified, but lamellar. It is supposed to owe its lamellar structure to a crystalline arrangement, like the plates of mica in a hexahedral pile.

Though these laminæ are often undulated, every variety of it may sometimes be split into roofing

* Vid. Dewey's Remarks, &c. Silliman's Journal of Science, Vol. II. p. 248.

slate; the whole rock is therefore called roofing slate by some authors. Whereas but one variety of transition slate affords good roofing slate. Several slate quarries have been wrought in this range in the counties of Rensselaer and Dutchess. There is little doubt but other good quarries will hereafter be discovered in it in the counties of Washington, Columbia and Orange, and in several counties in Vermont through which it passes. It is used for coarse walls, and some quarries afford good building stone.

This rock is greatly variegated in its colours. Where the turnpike road crosses the line between the states of Massachusetts and New-York, leading from West-Stockbridge towards Hudson, about thirty miles south of Williams College, is a remarkably interesting locality. Here, as we descend the hill on the New-York side, about three miles from the line, we see every variety of this rock in the space of one mile. Here are the deep-red, brick-colour, purple, bluish-purple, blue, green, and slate-colour. As to the colouring matter, I can say nothing from my own analysis. The green colour is unquestionably given by the chlorite. Dr. Higgins says, that the protoxyd of iron with magnesia is at first blue, next purple, then red, as the iron becomes more oxygenated, when in combination with rocks. Our primitive argillite, being more or less talcose, may owe its variegated hues to the magnesia of its talc being combined with that almost universal substance, oxyd of iron.

This rock is sometimes coloured with chlorite, a beautiful green, for many rods; particularly along

the west line of Massachusetts, between twenty and twenty-five miles south of Williams College; also near the west line of Vermont, in the town of Granville, about fifty miles north of Williams College. In the latter place there is also a remarkable locality of the red argillite.

Williamstown Mountain is mostly composed of shining argillite; in which the talc glazing is often very thick, almost equalling the thickness of the silver in silver-plaited ware. At and near the east foot of the mountain, I have collected specimens of the graphic slate, almost as dark coloured as plumbago.

In Pownal, Vermont, five miles north of Williams College, there is a locality of alum slate in this rock. There is another two or three miles north of New-Lebanon Springs. Both of these rocks produce alum salt spontaneously, by the action of natural agents.

Besides the very numerous veins of milky quartz, this rock contains the most perfect specimens, and the greatest quantity, of the beautiful green chlorite, of any rock in our section. It is generally connected with the milky quartz veins, giving a green hue to both the quartz and slate adjoining it. A few specimens of red and striped jasper have been found in Williamstown Mountain. Manganese and sulphuret of lead have been found in this rock in the middle and south part of Columbia county.—Cubes and parallelopipeds of iron pyrites, very large and perfect, are often found in it.

The Williamstown Mountain range extends into Canada north, and into New-Jersey south; a dis-

tance of between three and four hundred miles. Its course southerly is directly upon, and a little west of, the east line of the state of New-York, almost to the northwest corner of the state of Connecticut. Then it winds into a southwesterly direction, leaving Taghconnuc Mountain three or four miles to the east. It passes diagonally through Dutchess county, crosses the Hudson near Poughkeepsie, and runs under the village of Newburgh.

Though this rock holds on its course uninterruptedly, to a great distance, it is remarkably variable in its elevations. At one place it rises many hundred feet above the tide-water level, while it forms the bed of a low swamp, lake, or river, within a very short distance. Whenever it disappears beneath the alluvial deposits, we can never judge of its elevations and depressions, as we can of some other rocks.

This rock undergoes pretty rapid disintegration; though less so than transition argillite. It forms clay soil; which, when duly compounded with that produced from the sparry limerock which skirts its sides, forms a very productive soil. This is shown by the rich farms along the limestone valley of the Little Hoosick, and of that east of the mountain, into which the soil of the mountain is washed.

This rock does not approach the canal nearer than about twenty miles, where it is marked Williamstown Mountain, on our section. But a pretty full description of it seemed necessary, in order to make a just distinction between this rock and the transition argillite upon which the canal commences.

II. TRANSITION CLASS.

[Vid. Def. p. 32.]

10. Transition Argillite. [Vid. Def. p. 32.]

According to the definition, this is the lowest transition rock in our district. No rock geologically lower contains any petrifactions or coal. An orthocerite was certainly found in this rock in cutting out River-street, at the north end of Troy. Dr. E. James found anomites in the same rock, east of Lake Champlain. Mr. Knevels, of Fishkill, shewed me anthracite coal embraced in specimens of this rock, which he found near that place; and I found several specimens of it among the pieces quarried out of Mount Olympus under the direction of the canal engineers. Mr. Stebbins gave me well characterized sertularites embraced in specimens, taken from the rocky bluff in the city of Hudson, thirty miles south of Albany. This bluff is a naked rock belonging to this stratum, but consisting chiefly of the subordinate, flinty slate.

This rock is softer than primitive argillite, and generally more dull and earthy in its appearance. The laminæ approach nearer to a vertical position than those of primitive argillite, and the general direction of the stratum is more nearly horizontal; making the angle formed by the laminæ with its direction nearly similar. The laminæ are not so regularly undulated as those of many rocks of the primitive argillite. They are rather irregularly bent and twisted in all directions. There are some localities, however, where good roof slate might be

quarried. One in Troy, on the lands of Stephen Ross, Esq. has been wrought to a limited extent.—One has been laid open by Steney Brook, in Chatham, twenty-five miles in a southeasterly direction from Troy, on the lands of Maj. Eleazer Cady. The fineness of the texture and evenness of the plates, render this unwrought quarry valuable for the manufacture of the common cyphering slate.

The common kind, or *roof slate* division, contains veins of milky quartz; but not in so great quantities as the primitive argillite. Its upper surface, adjoining the next or sandrock stratum, contains numerous quartz crystals with pyramids on both ends of the prisms.

The *glazed* kind is generally very dark coloured, often black. The natural cleavages are glazed and most beautifully polished. I have never analyzed the glazing; but Prof. Silliman considered it a very hard variety of carburet of iron. Perhaps it may contain some talc also There are in this variety numerous broad oblique veins, or sheets, of striated quartz, of a very peculiar character. It is sometimes covered with a green plate, presenting a most perfect polish, which appears to be a semi-transparent plate of quartz coloured with chlorite; but I have not analyzed it. This variety of slate is found in and near the banks of the Hudson from Fort-Miller to near Esopus.

Alum Slate has been found in this stratum; but I have seen no specimens in it as perfect as those in the primitive argillite. It abounds in iron pyrites. Though the pyrites is sometimes in the state of hard cubic crystals, it is mostly of the soft granu-

lated kind. This variety is readily decomposed on exposure, forming sulphuric acid; which produces copperas, alum and epsom salts in many places, where it comes in contact with the proper salifiable bases. It decomposes water also; and this charges very highly with sulphuretted hydrogen, several springs. One of the strongest is in Greenbush, opposite Albany.

Beds of *flinty slate* are very extensive in this rock. Some geologists treat this as a distinct stratum;* and perhaps it ought to be so considered here.—But as it is absolutely in beds, and does not continue beyond either limit of the argillite, and is contained in beds only in the next rock above this, I cannot satisfactorily introduce it as a stratum. It appears at intervals on and near the banks of the Hudson, forty miles south and about as far north of Albany. Opposite to Troy, it is exhibited in a very perfect bed. It forms most of the bank of the Hudson River at and below the city of Hudson, passing into beautiful lydian stone in some places. The green *jaspery slate* variety is often in small beds; but the large mass three or four miles south of Albany, which was described by Dr. T. R. Beck and myself in the Albany county survey, probably exceeds in extent and beauty any thing of the kind in North America.

Though I am not permitted, by the patron of this survey, to indulge in that theorizing propensity which is so emphatically charged upon geologists; I may trace a few of Nature's footsteps, where the impressions still remain entire. I allude particu-

* See Geological Index, p. 176, with the cited authorities.

larly to the evidence that this rock was still in a soft state, after the three next rocks above it had become indurated.

The transition, or calciferous, sandstone, the metalliferous limestone and graywacke, now actually lie in succession upon this rock in many places, as I shall hereafter shew. At the Cahoes Falls and in both banks of the Mohawk, from the Falls towards its mouth, large and small masses of these three rocks are embraced between the standing laminæ of this stratum. The laminæ are bent around these masses, accommodating themselves to them on all sides. I believe the most cautious and sceptical observer will not hesitate to say, that these masses fell in between these laminæ while the latter were in a semi-indurated state. As this locality adjoins the canal bank, and as the canal at the top of the Cahoes is cut almost to the depth of thirty feet through the same rock, where some of these introduced masses may be seen; the reader, who travels the canal, is requested to confirm or disprove this position.

This rock rarely furnishes good building stone. They serve well for coarse stone fences; and are superior, probably, to all others for constructing mill-dams, as a substitute for gravel. It was applied in constructing the dam across the Hudson attached to the sloop lock at the north end of Troy, in the summer of 1822. In the following winter, when the gravelled and walled parts gave way; that which was filled in with this slate, endured.

The transition argillite is disintegrated on exposure in a shorter time than the primitive. I am

perfectly familiar with several fields in Columbia county, between twenty and thirty miles in a south-eastern direction from Troy, where the disintegration of this rock within the last thirty years is strikingly manifest. There are fields in which I remember to have seen rocky knowls of this slate thirty-five years ago, from two to six feet higher than the cultivated ground; which have now totally disappeared. Having been familiar with the course of cultivation in those fields during that period, I know that no artificial means have been adopted for reducing these rocky eminences. They have been reduced to soil by the ordinary process of disintegration alone.

The soil produced by the disintegration of this rock, contains too much clay when unmixed. But on being duly compounded with the limestone, sandstone and graywacke, which accompany it, the soil thus made is productive and durable. Such are the lands of most of the counties of Washington, Rensselear, Columbia, and parts of Dutchess and Orange. Several of the western counties in the state of Vermont have a similar soil.

This stratum is co-extensive with the primitive argillite, in a north and south direction. It passes down from Canada through the western part of Vermont, winding into the state of New-York in Washington county. It approaches the Hudson at Fort-Edward, and forms both banks and the bed of that river most of the way to near Newburgh. It has been traced by Dr. E. James and myself, more than three hundred miles in a north and south direction; for one hundred and thirty miles of which it is laid bare in the banks of the Hudson.

Its visible breadth, where our section crosses it, is about twenty miles. It extends from the west side of Little Hoosick to about three miles west of Cahoes Falls; embracing the Delta, or three mouths of the Mohawk. I say its visible breadth, though it is hidden more or less by overlaying rocks in crossing Rensselaer county. For if we commence with it near the Little Hoosick, and take a circuitous route to the north of Petersburgh, we may follow this rock without any material interruption.

About three miles west of Cahoes Falls this rock falls under the overlaying rocks, never to rise again. There is not an inch of argillite to be found in place as far west as Lake Erie, beyond this spot; and probably not on this side of the Mississippi.

11. Calciferous Sandrock, (*or Transition Sandrock.*)
[Vid. Def. p. 32.]

This rock is entitled to a place in the transition class; because it overlays a transition rock which contains marine petrifactions, and because it contains anthracite coal. But I have never seen any petrifactions in a rock, which I knew to be the true transition sandrock. Dr. T. R. Beck and myself found abundance of petrifactions in a rock resembling this in the Helderberg, twenty miles southwesterly from Albany. We considered that a secondary rock; and I believe the same rock is embraced in the secondary calciferous slate of the west, being a highly silicious variety of the water limerock. It may be seen in the abutments of a bridge in Jourdan; which was quarried five miles south of the canal in Camillus. It is more porous,

or of a more spongy appearance than the transition sandrock; and we found in it several petrifactions, which appeared to be calmiferous vegetables.

This is a very irregular rock in its form and structure. The exposed parts often appear like half-rotted roots of trees, and old stumps. When it is more compact and uniform in its texture, it is generally cellular, and abounds in geodes lined with crystals. On the northwest side of a creek in Galway, about fourteen miles north of Flint Hill, it is compact, and in square-faced blocks resembling the granular quartz near Williams College. It is frequently stalactitic on the under side of the layers; and we received one specimen of it which contained chalcedony covered with minute quartz crystals.

The most perfect locality, as well as the most accessible to those who travel the canal, is Flint Hill in Florida, and its continuation two or three miles west. In this locality we find dark-brown and pearly hornstone, brown and pearly calc spar, very large masses of coarse agate, quartz passing into chalcedony, petrosilex, and quartz crystals. A kind of bark-like ferruginous slate lines some of the interstices; and a soft slate, resembling the talcose slate, is often interposed between the layers.

Near Salisbury Meeting House, about ten miles northeast from Little Falls, near the west side of the Little Falls range of gneiss, a trench has been dug into this rock in searching for minerals. Here I collected specimens of anthracite coal, sulphuret of lead, sulphuret of zinc, green carbonate of copper, and quartz crystals. All these minerals were

disseminated in small masses, sometimes closely embraced on all sides by the rock, and sometimes in geodes. Both anthracite and sulphuret of lead have been found in this rock on Flatt Creek, a mile or two west of the Noses; also about the same distance west of Little Falls.

I collected numerous specimens of lamellar sulphate of barytes in this rock three miles west of Fairfield Academy, and about seven miles northwesterly from Little Falls. The rock which contains it is on the north side of a road, half a mile east of West-Canada Creek. Mr. Briggs, a canal engineer, found the same variety of barytes in excavating the canal west of Little Falls, where it traverses the same rock. In this range of the sandrock, near the last mentioned creek, Prof. Hadley collected more than half a bushel of most elegant limpid crystals of quartz, with pyramids on both ends of all the prisms. In truth, I could never find many feet of this rock destitute of crystals; and but few localities are wanting in other interesting minerals.

Notwithstanding this rock abounds in small masses of very interesting and valuable minerals, none have been found of sufficient extent to be worth working with a view to profit. As it affords valuable cabinet specimens, it will always be considered as an interesting rock; and may contain lead or anthracite in sufficient quantities to become an object to the miner.

This is a very extensive and important rock among the ridges and spurs of Macomb's Mountains. In a paper read before the Troy Lyceum by Judge

D. Buel, about four years ago, he says this rock is known among the farmers of that district by the name of bastard limestone. That it makes a meagre kind of lime on being burned in kilns. It skirts the ridges of gneiss at the margins of all the valleys among Macomb's Mountains, and entirely surrounds the spurs of gneiss which cross the canal at the Little Falls and the Noses. But its intermediate parts between these ridges, and between them and the graywacke, are covered with metalliferous limestone. The canal cuts through it at Flint Hill, and at other places east of the Noses; again between the Noses and Little Falls, and again two or three miles west of Little Falls.

The Flint Hill range runs in a northeasterly direction, passing about a mile northwest from Charlton Meeting House; but it is covered with the graywacke at the meeting house. The same rock, after passing under the metalliferous limerock and graywacke, rises again near the east side of the Noses. This range runs up, parallel to the former, near the northwest corner of Broadalbin, through the Fish-House village at Sacandaga, to Edinburgh Mountains. Proceeding along the canal line, it is interrupted by the Noses. It appears again at the west side of these gneiss ridges. This range runs up by way of Salisbury Meeting House. The range which lies up against the gneiss of Little Falls, passes up a little west of East-Canada Creek. By examining the profile section, these descriptions will be easily understood.

The stage road on the north side of the Mohawk is mostly on this rock, from Amsterdam to the Little

Falls, excepting where it crosses the gneiss range of the Noses, whenever it is within a few feet of the level of the Mohawk. Midway of the hill north of the road, the rock is generally metalliferous limestone, and the top graywacke. A most perfect exhibition of the order of the strata may be seen twelve miles east of Little Falls, on the north side of the Mohawk. Where the Johnstown road leaves the river road, the rock is calciferous sandstone. Half a mile east on the Johnstown road, the metalliferous limerock is seen lying immediately upon it, containing petrifactions of stylastrites. Two miles further on the same road, the true transition graywacke lies upon the limestone. The graywacke may be extensively examined in the bank of Garoga Creek.

This rock spreads out to a considerable breadth on the west side of the Little Falls gneiss ridge. Six miles north of the canal, it may be seen passing under the limestone a little west of the ridge. Near West-Canada Creek, it emerges from beneath the same rock towards the bottom of a hill. It may then be seen forming the banks and bed of the creek for several miles. It evidently leads away thence in a northwesterly direction towards the outlet of Lake Ontario, following the spurs and indentations of Macomb's Mountains.

It is as well characterized on the east side of the Hudson and of Lake Champlain, but occupies a much smaller area. Its extent from north to south is very great, running quite down from Canada to Barnagat on the Hudson, and probably much farther. It is generally but a few miles in breadth,

and often interrupted. It crosses our section as a naked rock near Little Hoosick, and a little east of the Hudson; but it is hidden most of the way directly on the line by overlaying rocks. It may be traced most of the way, however, by taking a northern circuitous route. It is well exhibited in a quarry one mile northeast from Mount Olympus, from which the backing stone for the sloop lock in Troy were taken by the canal engineers. A rock two miles farther north, called Diamond Rock, in Lansingburgh, is a very perfect specimen. The same appears again a mile and a half further on the stage road, at the west side of Speigletown village. It may be traced very satisfactorily by way of Bald Mountain to near the head of Lake Champlain, where it appears in square-faced blocks; thence along the east side of the lake to Canada. In a southern direction, it goes down in broken fields and patches, nearly parallel to the strata before described.

When the sloop lock was built, stones were used from a sandstone quarry at Barnagat, and from the quarry near the lock. Though quarried eighty miles apart, they agreed perfectly in all their essential characters; but those from Barnagat were in square-faced blocks, while those quarried near the lock were of very irregular forms. Both contained geodes of quartz and calc spar crystals; both contained the bark-like ferruginous slate, &c.

Though this rock runs under the graywacke, accompanied by the metalliferous limestone, from near the Little Hoosick almost to the Hudson, and appears again a few miles southwest of the Cahoes

in the same connexion, I have not been able to trace any connexion between it and that of Flint Hill. Perhaps the transition sandstone of the Green Mountain series may not be connected with that of the Macomb Mountain series.

Though this rock alternates with the limestone above it, viewing it only on the surface as we travel in the highways, yet I have never seen this rock lying upon the limestone. Probably these apparent alternations will always be found to depend on the disintegration of the overlaying rocks, leaving this rock in view at different intervals. It may be seen passing under the limestone in many places. It may be distinctly observed, passing immediately under the slaty variety of metalliferous limestone, on the bank of the canal between one and two miles east of Schoharie Kill.

Calciferous sandrock has been used as a substitute for the secondary water limestone. Bald Mountain consists partly of this rock, and partly of metalliferous limestone. The limestone has long been manufactured into the best of lime. The sandstone part has recently been employed by the canal engineers as a water cement. The same rock near the Cahoes has also been applied to the same use. Perhaps any rock which consists chiefly of quartzose sand and grains of carbonate of lime, if duly burned or calcined, will make a cement which will harden under water. From an expression which I remember to have read in Glauber's works, published about one hundred and seventy years ago, I am inclined to believe, such cements have been long made of similar rocks in Germany. I

would cite the article; but although I have the book before me, I cannot at present find it in that heterogeneous mass of sense and nonsense.

This rock is disintegrated rather slowly. The limestone part soon disappears on exposure, leaving a perfectly sandy surface. When uncompounded, it makes a sandy, and rather meagre soil; but if it is duly compounded with clay, the quartzose particles keep it loose, and the limestone part gives it richness.

12. METALLIFEROUS LIMEROCK, (*or Transition Limerock.*) [Vid. Def. p. 33.]

While this rock was united under the same name with that rock which I venture to call sparry limerock, there was some difficulty in making out the transition character. As that rock contains neither petrifactions nor coal of any kind, it held its place here on the presumption that it formed a continuous stratum with this rock. Since it has been pretty well ascertained that they are distinct rocks, separated every where by the interposition of the argillite, each rock takes its place in the system according to its proper distinctive characters.

The metalliferous limerock is decidedly a transition rock. It contains numerous petrifactions in and near the upper surfaces of most of its layers, and in some cases its whole substance seems to be made up of organic relics. These petrifactions are always of marine origin; consequently the upper surface of each layer which contains them, must have been the immediate bed of a sea, salt lake or ocean, a length of time sufficient to produce the

original prototype. Time was then required for the deposition of the layer next above; then another portion of time for the production and growth of the next layer of animal petrifactions, &c.

These successive layers, with their accompanying petrifactions, have been mentioned as geological chronometers. The number of years required for the growth of the animals may possibly come within the sphere of conjecture, by trials made with the living animal. The bottles of wine taken from the British ship which sunk in Hell-Gate, near New-York, during the revolutionary war, had living oysters attached to them of considerable size. If we suppose the largest to have commenced their growth within a year or two after the vessel sunk, we should conclude that a pretty good sized oyster comes to its full growth in about thirty years. Probably the smaller shell animals, as some species of anomites, which are most abundant in this rock, may have attained to their present size in eight or ten years or less. But how shall we fix upon any data, whereby we shall be induced to hazard a conjecture in regard to the time required for the intermediate deposits between the layers of petrifactions?

Though the petrifactions are generally found on the upper surfaces of the layers, and most numerous in the uppermost layers, I have seen petrifactions of the genus stylastrite of Martin, in a layer of this rock reposing immediately on the calciferous sandrock. That referred to in the description of the preceding rock, near where Johnstown road leaves the stage road, twelve miles east of Little Falls, is

a remarkable case. The same petrifactions are found in the same rock in the bed and banks of East-Canada Creek, between the last mentioned locality and Little Falls. This seems to be almost the only kind of petrifaction found in the lowest layers.

In some places the upper layers of this rock contain numerous petrifactions. A collection was made by A. Sackett, Esq. at the east end of Lake Ontario; and another by Mr. Sherman, at Trenton Falls, on the West-Canada Creek, eighteen miles north of Utica, which agreed in most of the species and varieties. In both collections, and in the rocks in place, I saw encrinites, entrochites, anthocephalites, terebratulites, gryphites, orthocerites, belemnites, trilobites, turbinites, and madreporites. I saw three distinct kinds of trilobite at Trenton Falls, each three or four inches across. One kind is not chambered towards the apex; in this respect resembling belemnites. Also orthocerites four feet long. The rock at these two places is manifestly the same continuous stratum, though they are about seventy miles apart; and there has never been a dry land or fresh water petrifaction found at either place.

I saw terebratulites and madreporites in the same rock, on the south side of the canal, at Chutmungo Creek, opposite to Amsterdam; also at Storring's in Charlestown. The same petrifactions are contained in this rock east of the Hudson, in Scaghticoke, twelve miles north, and in Greenbush, five miles southeast, from Troy. In truth, terebratulites are to be found by tracing this rock a short distance

in almost every place where I have examined it. Orthocerites too are very common in it, and also some of the sub-species of stylastrite. On Osequago Creek, half a mile south of the canal, the latter petrifactions stand in a vertical position, like the columns of favosite cells, along in the same layer for many yards. They are very abundant also in Galway limestone, and in Palatine, Fairfield, &c.

This rock is generally most compact near where it lies on the stratum below it. At this depth it may generally be wrought into very good marble. When it is compact, and contains numerous stylastrites, as on East-Canada Creek, it may be wrought into that beautiful variety called birdseye marble. Though its lowest layers are generally most compact, sometimes even the slaty variety is lowest. A mile east of Schoharie-Kill, in the south bank of the canal, this variety lies immediately on the calciferous sandrock. This variety may be advantageously examined in the side-hill which runs down south from the village of Canajoharie, at the Palatine bridge.

The metalliferous limerock is nearly co-extensive with the calciferous sandrock. Wherever the sandstone skirts the ridges of gneiss, the limestone overlays it, generally commencing from one to three or four miles from the foot of the gneiss range. This remark, however, applies to the Macomb Mountain series only. On the east side of the Hudson, this rock accompanies the sandrock more or less throughout its whole extent. It is so often interrupted, that it is rather a range of patches than a regular stratum. I have seen it in connec-

tion with the sandstone at different intervals from Barnagat on the Hudson, to near Lake Champlain. Dr. E. James has seen it in a similar situation all the way to Canada.

On our section, it manifestly passes under the graywacke near the Little Hoosick, appears once or twice in narrow intervals, and at length emerges from beneath it a little east of the Hudson. The graywacke hides it on all the highest eminences as it passes through the counties of Rensselaer, Columbia, &c. By inspecting our profile section between Williamstown Mountain and the Hudson, the reader will have a pretty correct view of the relative situation of this rock in most of its north and south range.

Though this rock, in the Macomb Mountain series, does not extend far south of the Mohawk at any place, it is considerably extended in a northwesterly direction from near the Little Falls. It runs in a curvilinear course, from the point of Fall-Hill, by way of Fairfield, Newport, Trenton, &c. with its southern margin about eight miles north of Utica, and ten miles north of Rome. Thence it continues in a northwesterly direction to the east end of Lake Ontario. In all this extent, it is separated from the secondary rocks by a belt of graywacke, under which it passes at its southwestern edge. The separate ranges of this rock are as numerous, and nearly as extensive, as the valleys between the ridges of gneiss; their middle parts being generally underlaid by this rock. The canal crosses four of these ranges, as will be seen on the geological profile.

Previous to my acquaintance with these extensive ranges of transition limerock, I had mistaken several transition rocks for secondary; consequently I had inculcated error in my geological lectures. And I am still much at a loss respecting some of the rocks which were examined by Dr. Beck and myself, in the Helderberg. The cornitiferous limerock which overlays the iron, salt, and coal formations of the west, is certainly the same rock which embraces Bethlehem cavern, twelve miles south of Albany. Several other rocks of the Helderberg perfectly agree in every character, essential and factitious, with some of those which overlay the secondary rocks of the west. Shall we say that these rocks are secondary, and that the western rocks are wanting in the Helderberg series? Do not the limerocks about Hudson and Catskill belong to the transition class, overlay transition sandstone, and pass under the Catskill Mountain graywacke? Is not the rock at Catskill, from which so many crystals are taken, transition sandstone? All these localities ought to be attentively examined by the members of the Hudson and Catskill Lyceums, after they have taken a canal tour, and attentively examined the transition and secondary limestones and slates; for rocks cannot be understood from an examination of limited or insulated patches. In order to generalize rocks, we must examine them in those districts where each rock may be inspected, and its relations observed over an area of several hundred miles. Then we may systematize those limited patches whose relations are obscured by alluvion, or deranged by disruption or other causes.

This rock, besides being wrought for marble, is used for walls, and for the manufacture of lime. Fort Johnson, on the north side of the Mohawk, about sixteen miles west of Schenectady, was built of this limestone. D. Buel, Esq. in a paper read before the Troy Lyceum, remarks, that "although it has been built about a century, the stones exhibit no marks of disintegration." Wherever it becomes soil, it enriches it like other limestones, and like them it requires a due admixture of clay and sand.

18. GRAYWACKE, (*or Metalliferous Graywacke.*)
[Vid. Def. p. 33.]

The canal is underlayed with graywacke rock from about three miles west of the Cahoes to ten miles west of Schenectady; and from about six miles west of Little Falls, probably to near Rome. But from Utica to Rome the alluvion is too deep, directly under the canal, to admit of an examination of the underlaying rock. From the direction of this stratum, it being almost horizontal, or a very gradually descending inclined plane, we are authorised to form this conjecture. That the graywacke underlays, at no great depth, all the western part of the state of New-York. I mean by no great depth, not exceeding six or eight hundred feet, or perhaps considerably less. It does not appear in view, however, any where immediately adjoining the canal west of Utica.

This rock spreads over most of that part of the state of New-York which lies west of the sparry limerock which crosses our section at the Little

Hoosick, south of the latitude of Schenectady, and east of the meridian of Onondaga Salt Springs. Some of the hills in almost every part of that area are capped with shell limestone, and others with old red sandstone or conglomerite. All the graywacke which lies south of the canal, is connected with the Catskill Mountain range; excepting that it is cut through by the bed of the Hudson, and by some other deep valleys and ravines. Its northern termination forms the south boundary of the secondary formation of the canal district, from a point about ten miles south of Little Falls, to the meridian of Manlius; all the way at the distance of from six to twelve miles.

The graywacke which lies west of the Little Falls ridge of gneiss, forms the northeastern limit of the secondary formation. It runs along about two or three miles southwesterly from the Mohawk; about the same distance south of the west branch of Fish Creek, and the same distance south of the general course of Salmon River, until it meets the southeast corner of Lake Ontario. The beds of the Mohawk, the Salmon, and this branch of Fish Creek, are chiefly upon or over this rock as far as it forms the boundary of the secondary district. This belt of graywacke will average about eight or ten miles in breadth, between the metalliferous limerock and the secondary formation, from near the Little Falls to Lake Ontario.

Though the graywacke spreads over a considerable area of country on the east side of the Hudson, it does not reach to a great depth. It is always in insulated fields, however extensive, whose boun-

daries can be traced. Though it covers its supporting rocks over more than half the square miles of Rensselaer county, we can trace its limits on all sides, so as to ascertain its underlaying rock. In this manner it spreads over a considerable proportion of Washington county on the north, and Columbia county on the south, capping the highest hills and most elevated ridges. In the same manner it caps the little eminences and hills near the Cahoes, while the canal is cut through the less elevated argillite.

The *chloritic* variety is found on the hills in Peterborough, and to great extent north and south, about the same distance west of the primitive argillite. But this variety is never seen west of the Hudson, nor within several miles on the east side of it. A beautiful *compact* kind is quarried in various parts of Rensselaer county. On some of the highest hills, this variety is coloured green with chlorite; which is scarcely equalled in beauty by any quarry stone of our district.

The *rubble* graywacke is very common in the vast graywacke district connected with Catskill Mountains. But that which belongs to the Macomb Mountain series, west of Little Falls, does not pass into this variety—at least I have not seen it well characterized there. The *red wacke* forms an extensive layer along the foot of Catskill Mountain, west and northwest of the village of Catskill, about forty miles southwesterly from Albany. My correctness in regard to this rock has been called in question by some good mineralogists; but my opinion has lately been confirmed by Prof. Silliman

and the President of Catskill Lyceum, who examined it in place. See Silliman's Journal of Science.

Grindstone grit and *hone slate* are very common in the graywacke rocks connected with Catskill Mountains. The best locality of the former which I have seen, is near the country seat of Judge Sutherland, in Blenheim, Schoharie county. The hone slate is most common in this rock. I have seen it of an excellent quality both in the Catskill and in the Macomb Mountain series, in many places. But I did not find the grindstone grit any where in the latter range.

This rock takes on the greatest variety of character of any rock in our district. It is coarse and harsh, soft and smooth, fissile and compact, brittle and strong, grey, blue, green and red. It appears in high perpendicular ledges, and even in receding steps of mountain height, and at the bottom of low rich alluvial valleys. It is sometimes in concrete globular masses, or concentric spheres. I saw these concretions three feet in diameter, in the town of Blenheim, before mentioned; also in Rensselaerville.* Notwithstanding these varieties, there is a striking peculiarity in this rock, by which we recognise it after seeing it once.

While we confine our examinations to that area of which I have given the boundaries, no material difficulties occur. But on travelling to the west, we find two rocks of great importance, which appear like some of the varieties of graywacke. These

* See Geo. Index, p. 196; also Albany County Survey.

I call *calciferous* and *pyritiferous* rocks, or second and third graywacke. They overlay or embrace all the secondary rocks of the west. Though they may not belong to the Catskill Mountain connexion, yet as varieties may be found greatly resembling them in this graywacke, I propose the following queries: At the northern termination of the graywacke, which is at the southern limit of the secondary formation, does the graywacke divide into three great layers? Do the iron, salt, and coal formations run in between the lowest layer (*metalliferous graywacke*) and the middle layer, (*calciferous slate*, or *second graywacke*,) leaving the middle layer among the secondary rocks? Do the geodiferous and cornitiferous limerocks run in between the middle and upper layers? The upper one is that which I call the *pyritiferous* rock, or *third graywacke*.

In the following descriptions, I treat these as three distinct rocks; for they have no connexion in the canal district. Perhaps they have no connexion at all, and are in all respects as distinct as other rocks. But the great resemblance between these secondary rocks and known varieties of the true transition graywacke, and their near approach to it at their southern extremities, are circumstances sufficient to induce the enquiry. It may be observed, that we have no evidence of a connexion between the graywacke of the Catskill range, and that of the Macomb Mountain connexion west of Little Falls.

Graywacke is said by some geologists to be geologically the highest rock which contains metals in veins. Others say, that metallic veins have been

found in old red sandstone, the next rock above this. Lead ore (sulphuret of lead) has been found in many places, contained in graywacke. Manganese has been found in this rock in various parts of Rensselaer and Columbia counties. There is a large bed of manganese in Blenheim, Schoharie county, on the south side of the Susquehanna turnpike. Iron pyrites is often found in it in cubes. Anthracite coal, in very thin beds, is found in it in the vicinity of Troy; also in Columbia county. Petrifactions abound in this rock, generally at the upper surface of the layers, in the manner already described under the metalliferous limerock.* Anomites and pectinites are common, with some other petrifactions, in both graywacke ranges of hills on the sides of the Mohawk, for the first ten miles west of Schenectady; also at intervals from Little Falls to Lake Ontario; also in the ridge or hill of graywacke upon which the village of Johnstown stands, in Montgomery county. The well characterized pentacrinites in the bed of the Mohawk, five or six miles west of the Cahoes, are beautiful petrifactions.

The rubblestone variety of this rock resists the action of the disintegrating agents, on exposure, for a long time. Therefore the small rounded masses of this rock, called grey hard-heads, are very annoying to travellers in all the highways in Washington, Rensselaer, Columbia, Dutchess, Greene, and some other counties. But the slaty varieties are not so durable. A soft variety of this slate,

* See Stevens' Graywacke Banks, described by Beck and Eaton in the Albany County Survey.

resembling the pyritiferous slate, (perhaps the same,) contains large quantities of the fine granular variety of iron pyrites. This rock is rapidly disintegrated, as may be seen several miles up Otsquago Creek, in Carlisle embracing the Schoharite variety of fibrous barytes, on Chuctenunda Creek, and in the banks of the canal three miles west of Schenectady. The soil formed from the soft slaty variety, contains too much clay when unmixed. The silicious varieties make a sandy soil. These being most abundant in the mountainous districts, the soil is often too silicious, and is underlayed with a kind of clay and gravel cement, called *hard-pan.*

This stratum passes under the *millstone grit*, the lowest secondary rock in our district, all the way from near Little Falls to Utica, and probably to Lake Ontario. Here is no room for conjecture; for we see the millstone grit lying immediately upon the graywacke in Steel's Creek, Myers' Creek, Ferguson's Creek, and Starch-Factory Creek. These very interesting localities, which will be often referred to, may be inspected on our profile section.

As this rock contains many useful minerals in small quantities, (which are enumerated in a preceding page,) it may be well for the members of the six scientific societies which are on or near it, to examine it with particular attention. Anthracite coal and sulphuret of lead may be reasonably expected in considerable quantities in some parts of its extensive area.

For farther accounts of this extensive rock, whose very existence in this country was question-

ed six years ago, see Dewey's Account of Rocks between Williamstown and Troy, in Silliman's Journal of Science; also the Index to the Geology of the Northern States, 2d Ed.

14. Old Red Sandstone. [Vid. Def. p. 34.]

The canal does not cross this rock; neither does it occur on our section nearer to the canal than Connecticut River. It is in layers alternating with the highest layers of graywacke, towards the top of Catskill Mountains, and of its subsiding ridges. A red sandstone appears in the highest parts of the hills from ten to fifteen miles south of the canal west of Little Falls, of an equivocal character. The saliferous sandrock becomes very coarse and harsh near where it crops out south of the Mohawk, as will be hereafter shown; so that it can hardly be distinguished from old red sandstone. It therefore becomes a question, whether those patches on the hills of graywacke are interrupted appendages to the saliferous rock of the secondary district, or whether they belong to the old red sandstone of Catskill Mountains. The grains appear to be less angular than those of the latter, and less rounded than those of the former.

This appears to be a more important rock in Europe than in our district; though we consider its place in our series of rocks equally important. It is the limitation stratum upwards of all metallic veins, and it is the limitation downwards of bituminous coal. This, at least, is the decision of most European geologists. There has been considerable controversy, however, respecting its being in all

cases beneath the bituminous coal formation. Probably the differences in the opinions of geologists proceeded from the great similarity in some cases between this rock and the saliferous rock, or second red sandstone of Werner, as in the cases just referred to.

Werner placed this rock in the secondary class; but in our district it cannot be placed there, according to the definitions of the classes. The bones of quadrupeds said to be found in this rock in East-Windsor, Con.* were certainly in a rock which cannot be called the true old red sandstone. It may be called *breccia*, if that stratum is tenable. If that is rejected, it belongs probably to the saliferous stratum. At any rate, it is totally unlike the old red sandstone of Catskill Mountains, or any European specimens which I have seen. I have examined that locality extensively on all sides, and it appears to me to be the very same secondary rock, which contains recent organic relics, on the west bank of the Hudson, between and under the Palisadoes. Also the same as Mount Toby on Connecticut River, which Mr. Hitchcock has marked, the coal formation.

The President of the American Geological Society, William Maclure, Esq. says he prefers putting the old red sandstone in the transition class. Bakewell places it here also, and Jamieson half assents to it, though one of the most rigid followers of Werner. Being supported by these authorities, and having been unable to discover any petrifac-

* See Silliman's Journal of Science.

tions in it but those of marine origin, I still continue to retain it here.*

Since this is the stratum which underlays the most important coal measures in Europe, and since it is wholly wanting in the canal district, we must of course take the rock whose geological place is next beneath it, for the true floor of the coal formation. This being the graywacke rock, wherever the old red sandstone and graywacke are both present, we must of course take the graywacke rock which passes under our secondary rocks, for the supporting stratum of the coal, salt, and iron formations of the canal district.

But few interesting minerals are embraced in this rock. It contains a petrifaction of corallines, or stylastrites, in abundance, and of great length. A single specimen may often be seen, with several branches many feet in length. Beds of copper ore, it is said, have been found in it.

It is not subject to very rapid disintegration, and is esteemed a valuable and durable building stone. It is wrought in many places under the name of red freestone. It forms a red, loose, meagre soil, uncompounded; but is of great value as a compound with clay.

* See Index to the Geology of the Northern States, 2d Ed.

III. SECONDARY CLASS.

[Vid. Def. p. 35.]

15. Millstone Grit. [Vid. Def. p. 35.]

According to our definition, a secondary rock should embrace bituminous coal, or the relics of organic substances of dry land or fresh water origin. As the most recent strata are the highest, it follows, that a stratum, which contains no intrinsic evidence of its secondary character, is entitled to a place in this class, if it overlays a stratum or substance which is decidedly secondary. The millstone grit in our district is not known to embrace or overlay bituminous coal; but in Europe it is often connected with the coal measures. As it actually adjoins the second red sandstone of Werner, or saliferous rock of more modern geologists, in the canal district, it overlays the geological location of bituminous coal, as I shall soon shew; consequently it is a secondary rock.

It is not to be expected that every rock, in every locality on the globe, will present its classic characters. It is sufficient for classifying a rock, to prove that it exhibits its classic characters any where in any country, provided we can identify the rock under consideration with that whose classic characters are manifest. Now the millstone grit is one of those peculiar rocks, which can never be mistaken in any country. Its harsh, sharp-gritted texture; its hard quartzose accompanying conglomerate, and all its other peculiar features, can

never leave any doubt on the mind in regard to its identity. I venture therefore to say with confidence, that the rock stratum which is interposed between the graywacke and the saliferous rock in our canal district, is the secondary millstone grit, which accompanies the most important coal measures of the eastern continent.

This rock may be seen reposing immediately on the transition graywacke, at Starch-Factory Creek, near Utica village; at Ferguson's Creek, Myers' Creek, and Steel's Creek. These places are marked on our profile plate. It may be seen in a quarry three miles south of Rome, in the northwest corner of Westmoreland, reposing on graywacke. The overlaying rocks seem to have passed away here, and also most of the way for four or five miles in a southerly direction. A very interesting locality may be seen on a Mr. Forster's land, adjoining the great swamp, six or seven miles south of Rome. It appears also in the low valleys and ravines north of Hamilton College, and in various other places between Little Falls and Vernon. Wherever it appears, there is the clearest evidence of its being laid bare by the disintegration of the overlaying rocks, excepting in the ridge south of the canal from Little Falls to Utica, &c. Here, as appears in the creeks before mentioned, this rock, and the three next overlaying rocks, crop out and terminate.

This and the two uppermost strata, are the only secondary rocks of the canal district, which do not present themselves in regular succession in the Genesee River, near Rochester. There the red saliferous rock being the lowest in view, this is un-

doubtedly concealed beneath it. For we have very high evidence that it is co-extensive with the red rock; some of the most important are the following: B. Byington, Esq. bored through the red saliferous rock at the Onondaga Salt Springs; immediately beneath which he came to a conglomerate rock, into which he bored eight feet. Some of the fragments which he brought up, I have before me. The fragments are too small for accurate examination; but the aggregate seems rather to resemble some of the European varieties of conglomerate which accompany coal measures, than the conglomerate variety of millstone grit. The latter is much harder than the aggregate bored into by Mr. B. which was chiefly made up of pebbles cemented together by carbonate of lime. This proves, however, that the red rock is underlayed by a stratum which often accompanies the millstone grit. The most important fact in evidence of its underlaying the saliferous rock far to the west, is, that it accompanies it wherever it crops out, from ten miles south of Little Falls to near the Mohawk, thence all the way in a northwest direction to the southeast corner of Lake Ontario; a distance of about one hundred miles. In many places south of the Mohawk, between Little Falls and Vernon, where this rock is laid bare in ravines, &c. we see the saliferous rock lying immediately upon it. From Tisdale's old mill, three miles south of the canal, and eight miles southwest of Little Falls, to Vernon, is about twenty miles on the longitudinal course of the canal district. At intervals through this twenty miles, we find this rock at the

bottom of deep hollows, with the red saliferous rock overlaying it, and often find the ferriferous strata upon the red rock.

I have seen boulders of this rock, such as we see near the south side of the canal two or three miles west of Oriskany, more than twenty miles south of the canal. And it seems to form the south-east corner of the secondary district near Brown's mills, at the head of Otsquaga Creek, ten miles south of the canal. Here it is in broken fields and patches.

This stratum, where it appears in full thickness, is from about forty to sixty feet in several perpendicular ledges. It does not pass into, nor alternate with, the graywacke upon which it lies. Here is, therefore, a very convenient place for separating the transition and secondary classes. All the accompanying secondary rocks are much harder at and near where they crop out, than in Genesee, Oswego, and Niagara Rivers. Probably this rock is harder here than it is farther west. As an evidence of this, it becomes a white sandstone, suitable for the manufacture of glass, at one place in the town of Vernon, twenty miles west from where it crops out. Sometimes it is quarried for building stone; but where it passes into the conglomerate variety, it is chiefly used for millstones. It seems to be the same rock as that from which the well known Esopus millstones are manufactured. I never visited the Esopus quarry, and am a stranger to its geological associations. The conglomerate variety is sometimes white, sometimes yellowish or reddish; being coloured with the oxyd of iron.

I saw in this rock, in the quarry mentioned near Rome, in the northwest corner of Westmoreland, several petrifactions; some were of bivalve shell animals, and others I took for corallines. On a re-examination, I am at a loss respecting them. Those which I have before me, appear quite as much like culmiferous vegetables; but my specimens are imperfect. In the same quarry I found sulphuret of lead, sulphuret of zinc, and calc spar. About a mile east of Vernon village, I found a very similar locality, with similar embraced minerals.

This rock being interposed between the limitation strata of the most important coal measures of the eastern continent, the enquiry, whether there are coal beds in connexion with it here, very naturally occurs. If there are coal beds beneath the saliferous rock and above the graywacke, in connexion with the millstone grit, &c. why has no accidental discovery of some of them been made, in an inhabited district of between two and three hundred miles in length? To this, it may be answered, that there is no chasm, ravine, nor worn bed of a river, which lays open to view the lower surface of the red saliferous rock, west of the town of Vernon. The perforation made by Mr. Byington at the Onondaga Salt Springs, appears to be the only opening ever made through the red rock, between the meridian of Vernon and the west end of Lake Ontario, in the British dominions. Therefore, if there is ever so much coal in those geological associations in which this mineral is found in greatest abundance on the eastern continent, we could not possibly know it; because no one has

ever seen one foot of that space which the coal would occupy.

It may be said, that in Europe the coal often appears at the out-croppings of those rocks between which it is embraced. Why then do we not meet with some coal along the range of one hundred miles, where these rocks crop out, from below Little Falls to the southeast corner of Lake Ontario? This is certainly an argument against the probability of the existence of coal in the canal district. But there is no salt water above the red rock within about twenty miles of these out-croppings, which perhaps is an equal objection to the existence of a salt formation here. Still there is more and stronger brine springs on this rock, as their common floor, than in any explored region of the earth. It may be proper here to remark, that all the rocks are harder, and all but the red rock thicker, at and near their out-croppings, than at Genesee River, and other places where they are to be seen farther west. In the latter localities, the largest proportion of the red saliferous rock, is a soft brittle slate, in which the sandstone part is embraced. Whereas at its out-croppings there is but very little slate, at most places none, and the sandstone is much harder.

In Europe, coal is often found under this rock, at the depth of from four to six hundred feet. The thickness of the red saliferous rock in our district is not known. More than one hundred feet of it may be seen at and below the lower Genesee Falls; but we have no means of determining, by any course of observation, what is the remainder of its

thickness. If we should bore from the bottom of the lower falls, we should probably make some interesting discoveries. But there may be millions of millions of chaldrons of coal between this rock and the graywacke rock beneath it, without our being able to hit upon a bed of it, at one, two, three, or even a dozen borings. Our countrymen are, very commendably, more inclined to embark in a course of enterprise where a due measure of profit is certain, than to hazard much time and money on scientific speculations. But at some future period, when our western forests are cut away, and fuel becomes scarce and dear, I have little doubt but repeated trials by boring will be made in various parts of the district which is underlayed with the red saliferous rock, and that vast beds of coal will be discovered beneath it, in connexion with the millstone grit. It appears unreasonable to suppose, that our country forms such an extraordinary exception, that the same kind of coal formation, which never proves barren in Europe, should here prove abortive through its whole length of more than two hundred miles.

I will add one fact for the consideration of practical geologists. Near Vernon Center, we find the first salt spring on the red rock, as we proceed westerly from the often mentioned out-croppings of the secondary rocks. Here too the rock is more slaty, containing but little sandstone. Four or five miles farther west, one mile west of Vernon village, and five miles south of the canal, carburetted hydrogen gas issues from beneath the same red rock in great quantities. I say the same rock, because

from the wells and other appearances, I satisfied myself that this is the principal underlaying rock here; though the ferriferous strata overlay it in the hills. The gas issues through gravelly soil at the foot of a hill, at the rate of about one gallon in a minute. I collected measures of it by the watch several times. It is precisely the same carburetted hydrogen gas which is produced in most coal mines. To save the workmen from the explosions produced by igniting this gas when combined with atmospheric air, Davy's safety lamp was introduced. It burns with a flame which is not so white as that of the artificial coal gas; neither does it partake of that blue colour which is exhibited in burning the light carburet produced by decaying vegetables. I believe the production of this gas has always been considered as a strong indication of the presence of coal. Dr. Hays, of Canandaigua, analyzed a similar gas, similarly situated, six miles from that village. This gas may be produced by the decomposition of water by coal, at a great distance from the place where it issues; but it would follow a natural cleavage between two layers of the rock from which it issues.

By disintegration, this rock produces a gravelly and sandy soil. When mixed with the soft alluminous graywacke slate beneath it, or the soft ferriferous slate above it, a productive soil is made.

16. Saliferous Rock. [Vid. Def. p. 35.]

This is the most important of all rocks in the eastern continent. It will probably be deemed equally important here, when its relations to the

useful minerals are understood. To preserve our food from putrefaction, and prepare it for the table by the aid of heat, and to defend our bodies from cold, are among the chief concerns of human life. Salt being essential to the first object, and coal necessary for the other two, in countries where the timber is cut away, we view any indication of the existence of these substances in the earth, with deep interest. Wherever an European miner or geologist discovers this rock, he feels the strongest assurance that rock salt, or salt springs, may be found in and upon it, and coal beds below it. More than fifty salt springs have already been found in this rock in the canal district; but whether there is coal beneath it, has not yet been ascertained. For reflections upon that subject, read the article Millstone Grit.

From near Little Falls, to the west end of Lake Ontario, in Upper Canada, this rock may be traced in the most satisfactory manner. It is about two hundred and fifty miles in length, and something more than twenty miles in breadth, on an average. Its north boundary for about two hundred miles, is Lake Ontario. Its thickness, where it crops out on Steel's Creek, and some other places, will average about eighty feet. But a Mr. Bennett bored into it one hundred and forty feet, from the bottom of Oak-Orchard Creek, seven miles south of Lake Ontario, and did not reach its lower surface. At and below Lower Genesee Falls, and at the mouth of Niagara River, a thickness about equal to Mr. Bennett's boring may be seen, without any evidence of a near approach to its next underlaying stratum.

This rock is manifestly the floor of all the salt springs of the canal district. It descends like an inclined plane to the Genesee River; where it is about two hundred and fifty feet lower than at the ridge between Little Falls and Utica, where it crops out and terminates. From the Genesee River westerly, it is an ascending plane. It rises up to the canal level eight miles west of that river; though where it crosses the river on the same level, the upper surface of the rock is considerably more than one hundred feet below it. This difference, however, does not depend wholly on the general western ascent of the rock; for it also ascends as it recedes from the lake.

To have a correct conception of the form of this rock, we must view it as the southern side, or brim of the great elliptical basin, which holds the waters of Lake Ontario. The most southern part of its curvature, or the southern extremity of its conjugate diameter, is on the Genesee River. It then follows, that if a line be drawn nearly straight from east to west, within one side of this basin, near its edge, this line would descend towards the Genesee River from both extremities. But on going a little south towards the rising of the brim, the canal level would soon traverse this rock.

Beginning at its eastern limit, where it crops out near Little Falls, on the Mohawk, we find no salt springs within about twenty miles. Throughout this twenty miles, the rock is mostly of the red sandstone kind, and more coarse and harsh than it is farther west. But near Vernon Center, seven miles south of the canal, where the first salt spring occurs,

the red slate appears with the red sandstone, in considerable proportion. This spring issues from the upper surface of the rock, on the west side of the Skanando Creek; whose banks consist of the soft red saliferous slate, beautifully spotted with nodules of green slate, resembling the ferriferous slate.

The next spring which I saw, is about nine or ten miles west, on the lands of Sidney Breese, Esq. There is another in the same direction in Lenox, and about the same distance from the last. The descent of the rock is very uniform along the line of these springs, and also all the way to Salina or the Onondaga Springs. The springs farther west, as at Montezuma, Clyde, &c. are still deeper; probably in the same ratio. Beyond the Genesee River they are more elevated, according to the ascending course of the rock.

The descent of this rock in a north direction towards Lake Ontario, is not uniform. It falls away by offsets, like the graywacke of Catskill Mountains; differing greatly, however, in degree. The edge of the principal offset forms a kind of ridge, whereon a road is constructed, called Ridge Road. I examined this ridge for about one hundred and fifty miles, along the south side of the lake; it being from about four to eight miles distant from it. It is not so uniform on the east side of Genesee River, as on the west side. The offset becomes double, or branched in a few cases, in the latter division.

Several gentlemen of distinguished talents have constructed very ingenious theories, to account for this extensive and very accommodating ridge. As

it bears some resemblance in form to ridges of sand thrown up along the east end of Lake Erie, and on the shores of other great collections of water, it was said that this ridge might have been formed by a similar process. This was adduced as an evidence that Lake Ontario had formerly stood at a much higher level than at present. Perhaps there may be other evidence of the ancient elevation of the waters of the lake; but this is a subject which I was not directed to investigate. As it respects the ridge, while the talents of the learned and the ingenious are put in requisition to account for its existence, a mere hireling drudge, less elevated in his views of the grandeur of Nature's "intestine wars," would examine the underlaying rock, and follow the course of the offsets. He would find, that wherever a creek crosses the ridge, and leaves the rock bare, it discloses the rounded edge of a rocky step; also that the edge is often a little elevated, like the steps in Catskill Mountains. Whether this elevation is caused by the original superior hardness of the rock, or whether an exposure at the edges of such aggregates, to solar heat, enables them to resist the operation of the disintegrating agents for a longer time than where perpetually moist and damp, I shall not give an opinion. So is the fact, however, that I have seen elevated ridges at the margins of such offsets in numerous localities, and that this rock does present such a margin under the Ridge Road.

The saliferous rock is no where in view of the canal east of Genesee River, though it evidently runs under it at a greater or less depth, from near

Rome. About eight miles west of Genesee River, this rock forms the bed of the canal; and it is the immediate underlaying rock from that place to within a mile of Lockport, a distance of about fifty miles, excepting a few miles at Windsor village, and in a few other limited spaces. The best locality adjoining the canal, for an examination of this rock, is at the culvert on Oak-Orchard Creek. Here are the red and greenish-blue varieties, containing most perfect petrifactions of the stylastrites, with very distinct transverse or torulose ridges. Up this creek two and a half miles, at Ellicott's Mills, the calciferous slate, containing water limestone and snowy gypsum, overlays this rock. Probably the ferriferous rocks are interposed, but the intervening alluvion prevented an examination. At Holley Village culvert, is the only salt spring in this rock, immediately adjoining the canal.

The name, second red sandstone, which is by some applied to this rock, is very inappropriate; because it consists of soft scaly red clay slate, red sandstone, and blue or greenish-blue slate and sandstone. Much the largest proportion of the sand and slate is red, however. The sandstone part is quarried in many places, and much esteemed as a building stone. The slaty part is mostly very soft, and in irregular fissile laminæ. It is much harder where it crops out, than it is in the vicinity of the salt springs, and is not accompanied with the red slate.

We have a most perfect view of this rock, with the five next strata above it, in Genesee River, near Rochester; in Irondiquot Creek, four miles east;

and in the Niagara River, between Lewiston and the Falls. In all these places, the thickness of this rock is unknown. In Genesee River, we see eighty feet of it in the lower falls, and perhaps between fifty and sixty feet more below the falls. The *grey band* over it is four feet thick; the *ferriferous slate*, twenty-three, with one foot of argillaceous iron ore on its upper surface; the *ferriferous sandrock*, fourteen feet; the *calciferous slate*, seventy feet; the *geodiferous limerock*, thirty feet. To find all these strata, we begin at the lower falls, and proceed up stream to where the canal crosses it; and then follow the canal about half a mile east, to where it is cut through the geodiferous limerock. In Oswego River we have an excellent view of this rock, and throughout the whole extent of Lake Ontario, at short intervals, on or near its south shore. It is also brought into view by the disintegration of the overlaying ferriferous rocks, at intervals, from Little Falls to Oneida Creek, within a breadth of ten miles south of the canal.

The most important beds of rock salt in Europe, are situated in or upon this rock. Wherever there are salt springs, and no rock salt is discovered, it is the prevailing opinion, that there are undiscovered beds of rock salt in the vicinity, which give saltness to the waters by perpetual solution. The same opinion is almost universally received in regard to the salt springs of the canal district. But I am inclined to doubt our being in possession of conclusive evidence in favour of that opinion. Take, for example, the spring before mentioned on the Skanando, near Vernon Center. From that

spring to where the rock crops out near the Mohawk, almost every thing may be known of it from inspection. In the deep channels and chasms, we ought to find the rock salt, in this limited portion of the district, which must supply this spring. And even throughout the whole saliferous stratum, we have opportunities for inspecting it deeply; and though we frequently meet with salt water, we have no knowledge of the existence of a particle of rock salt. To be sure, its not having been discovered, is not conclusive evidence that it never will be; but our intimate acquaintance with this rock to so great a depth, in so many places throughout its vast extent, ought, before this time, to have disclosed at least a small sample of rock salt; more particularly so, as the great supply of salt water in such a large district, requires immense beds of salt to afford the requisite solution.

Would it not agree better with analogous productions, to say that this rock, and some of the overlaying strata, contain the elementary materials; and that the brine springs are the daily productions of Nature's laboratory? We see the production of epsom salts going on daily in numerous localities. We know how this is formed. We see the sulphur in iron pyrites taking oxygen from water, and thereby becoming sulphuric acid; we then see it uniting with magnesia, which is diffused in rocks, and thus forming epsom salts. This salt appears in a state of efflorescence in dry weather; but is washed away in the first shower. These materials sometimes abound in alluvial deposits. There is a remarkable locality on the lands of H. Hickock,

Esq. on the banks of the Hudson, seven miles north of Troy. I saw more than twenty of these small workshops of nature, in the calciferous slate overlaying the salt rock. We are all familiar, too, with the process of nature, by which alum and copperas are made. Why may we not suppose, that the two constituents of common salt (muriatic acid and soda) are in some state of combination in the rocks of the salt district, and that by some of those double decompositions with which nature is perfectly familiar, salt is produced in the liquid state? May not this be a cause of the superior saltness of the brine springs of Salina, over those foreign springs which are supposed to proceed from the solution of rock salt? For the salt, being at first formed in a solvent state, is carried on to the tunnel-form reservoir at Salina with very little water.

I have already given an account of the production of salt from the exposure, in a damp cellar, of a piece of one of these overlaying rocks, in Silliman's Journal of Science. This was taken from a bed of water limestone embraced in the calciferous slate stratum. I have not made as many trials with the different rocks of the salt district, as I intended to have done before this time. I do know, however, that several rocks in that district will shoot out acicular crystals of common salt, on exposing pieces of them in a damp cellar. Whether they contain ready made muriate of soda in a liquid state, or its elementary constituents in other states of combination, is not so easily determined as might be imagined; for all the common tests will give the same

results in both cases, and there would generally be a little taste of saltness in either case. I have selected specimens from rocks one hundred feet higher than the highest of the brine waters, in which I could not perceive any salt taste; which would shoot out salt crystals in three days, on exposure as before. I thought this perfectly conclusive evidence that the rocks contained the elementary constituents of the salt, not combined in the state required for its production, until I learned the following fact:—A merchant in Troy built a store on the same ground where a grocery had once stood, in which salt had been retailed. Twenty years afterwards, I saw acicular crystals three inches in length, shooting from the earth in the bottom of the cellar. On trial, neither myself nor any other person could perceive much, if any, taste of saltness in the earth from which the crystals proceeded. This fact almost made me a convert to that theory, which supposes the brine springs to proceed from strata which absorbed the salt waters of the ocean, while it stood over the earth. While these waters have been gradually draining down into the lowest cavities, what is left would become less dilute; consequently the waters would perpetually increase in saltness. In some localities, by perpetual draining and evaporation, the brine would be brought to that degree of strength which is required for crystallization, and rock salt would be formed. This theory would not admit of rock salt solutions for the supply of salt springs, excepting a partial supply, produced by rains and other incidental causes; but would suppose, that there is in connexion with the beds of rock salt, a remainder of the primitive

oceanic brine, which is not yet sufficiently strong for crystallization. We might then add, that artificial means are now used for bringing the brine at once to that state, by evaporation, which nature will effect in due time.

With regard to the depth to which the salt extends, there appears to be sufficient evidence that it is diffused, in some places at least, throughout the whole substance of the red saliferous rock. The strongest waters being the heaviest, they would naturally sink down the lowest, where there is no obstruction. Or the waters may be made stronger, by perculating one or two hundred feet through a rock, containing or producing salt throughout its mass. It appears, from many trials, that this is the fact, whether we are or are not able to discover the cause. Mr. Bennett found that the waters grew stronger and stronger, throughout the whole of the one hundred and forty feet hole which he bored into this rock, in the bed of Oak-Orchard Creek. Mr. Byington found that the waters grew stronger at every foot he bored into this rock at Salina; but after he had bored through the rock, he found that he gained nothing by boring eight feet farther, into the conglomerate rock beneath it.*

Why are beds of rock salt, or brine springs, connected with this rock, rather than with graywacke, argillite, geodiferous limerock, or any other stratum? I would answer this enquiry by asking, why is tin always confined to granite and gneiss? Why

* For localities and the manufacture of salt, see Dr. J. Van Rensselaer's Essay on Salt.

is arseniate of cobalt always limited to hornblende rocks? Finally, can we account for any one of those associations which are known to be universal? European geologists speak of some constant associations of salt, however, which do not exist in our district, particularly the gypsum. Gypsum is never associated with the salt formation in the canal district. I am aware that it has been often asserted, that gypsum and salt are two constant associates in the state of New-York. But there are certainly three distinct strata, including the iron formation, between those which contain the gypsum and salt, where they approach the nearest, between Oneida Creek and Genesee River; as will be shewn under calciferous slate. Beyond Genesee River, the salt springs are not only geologically, but geographically, remote from each other. Being valuable minerals, and both being found in some towns not very remote from each other, many persons have contented themselves with the presumption that they were associated as in Europe, without an examination. This fact is calculated to discourage us respecting the existence of coal beneath the saliferous rock. For if gypsum is not associated with salt above it, there may be the same deviation from the geological associations of Europe, in regard to the coal below it.

The impurities contained in the brine springs, if carefully analyzed, might throw much light on the subject of their origin. This would require an extensive course of experiments, made at the springs, where the experimenter could avail himself of numerous samples of every substance contained in

the waters. Dr. Macneven, of New-York, has lately analyzed a specimen of the dry salt, and gave the following results:—In one hundred parts, he found 93.194 of muriate of soda, 2.525 of sulphate of potash, 2.269 of muriate of lime, and 2.012 of muriate of magnesia. If this gentleman could absent himself from his numerous and useful avocations long enough to analyze the waters at the springs, and give the public the same accurate results for all the substances contained in those waters, science would be under additional obligations to him.

The sandstone part of this stratum has but recently come into use, as a building stone, in this country; and I am not informed on the subject of its durability in Europe. It is easily wrought into suitable forms for any use, and is the handsomest of all the varieties of red freestone. It is now so much in use at Rochester, on Genesee River, that the effects of the disintegrating agents upon it will be understood in a few years. The slaty part of this rock is soon dissolved into a red soil. Dr. A. Baldwin, of Clarkson, told me that he had seen varieties of this rock, which would be perfectly dissolved into red clay in ten days of rainy weather; and that on an average, one month of rainy weather would bring any of this slate in that vicinity to the state of red clay on exposure. But it is not in all places so readily dissolved.

17. Grey Band, (*or Grey Felsa.*) [Vid. Def. p. 36.] I find this rock very well described in Williams' Mineral Kingdom. He describes several varieties.

most of which are very soft, or soon become so on exposure. As he represents some of the varieties to be tolerably hard, and as his description agrees with the rock under consideration in all other respects, particularly in its geological relations, I assume this name for it. Williams describes the grey band as the coal roof in some cases. From his manner of treating it, it appears to be the coal roof where the saliferous rock is discontinued. Lying immediately upon the saliferous rock, it would of course be the coal roof here, if the saliferous rock should be at any place discontinued.

This is rather a soft rock at Genesee Falls, and some other places; but it is a hard rock where it crops out, and in most other exposed situations. Therefore it does not so perfectly agree with the European grey band as could be wished. I can find no other name, however, in any treatise, which approaches its character in the descriptions given. At the Lower Genesee Falls, it appears like a grey fillet, beneath a wider green one. Being interposed between the red saliferous rock and the bluish-green ferriferous slate, its appearance is very conspicuous and beautiful.

Though this is of less thickness than any other secondary stratum in the canal district, it is so perfectly distinct from the adjoining rocks, besides appearing to be uninterruptedly continuous for two or three hundred miles, it could not with propriety be set down as a subordinate rock. It is four feet thick at Genesee Falls, eight feet on Niagara River, twelve feet on the creek east of Lockport, and fifteen feet at most places where it crops out with

the saliferous rock near the Mohawk. Dr. E. James says, that grey sandstone covers the red in the salt district west of Mississippi. As this rock passes into sandstone in many places, it is probably the same rock. Its immediate connexion with the red saliferous rock and the salt springs of the west, may entitle it to the appellation of *grey saliferous rock*, if the name grey band should be considered as misapplied.

I have seen no rock in our whole section, which presents so few subjects of interest as this. It may hereafter be found to embrace some interesting mineral substances; but I have seen nothing in it, though I have examined it diligently at intervals, for more than two hundred miles. It varies considerably, however, in its texture and its constituents. In some places it seems to be considerably argillaceous; in others, almost wholly quartzose sand; in others it contains considerable carbonate of lime.

In many places it makes a good building stone, dividing naturally into square-faced blocks; in others its fracture is somewhat conchoidal, particularly at Genesee Falls. It is then easily wrought with the chisel, and takes an indifferent polish. I have seen no soil made from its disintegration. It would undoubtedly vary according to its varying constituents.

Without a description of this rock, the student would be embarrassed with it, who should attempt to examine the canal rocks by this report. It was therefore necessary so far to notice it, as to enable him to recognize it.

REMARKS

ON FERRIFEROUS ROCKS.

The iron formation of the canal district is highly interesting to the geologist, and of great value to community. It consists of two distinct strata, totally unlike, but which always accompany each other, and their layers sometimes alternate. The lower stratum is soft slate; the upper one is a sandrock. The iron ore is mostly the argillaceous oxyd, sometimes passing into the jaspery variety. The best kind is the lenticular variety, containing fresh water petrifactions. The principal petrifactions appear to belong to the genera *helix* and *lymnæa*, according to Say. It being the peroxyd of iron combined with alumine, the colour is bright red, and it is of a soft texture. It may be scratched and pulverized with the nail, and even some specimens may be rubbed into a fine powder between the fingers. It has an unctuous feel, and gives the fingers a deep and permanent stain. Though it will generally give but about thirty per cent of iron, it is so easily reduced or freed from its oxygen, that it is a very profitable ore. The jaspery variety is hard, silicious, and difficult to reduce. It is not at present used at the furnaces.

Sometimes the ore is in a distinct bed or layer between the two ferriferous strata. It is more commonly attached to the upper surface of the slate, and intermixed with the layers of sandstone. Sometimes it is embraced between layers in both

rocks. In the banks of Genesee River at the falls, it appears like a distinct stratum between the two rocks. It has the same appearance in some other places. It is so remarkably continuous, that there would perhaps be no impropriety in calling it a stratum of argillaceous iron ore. I have seen it between, and in the adjoining parts of these rocks, at frequent intervals, from near Little Falls to Queenston in Canada, a distance considerably exceeding two hundred miles. It is never wanting in the canal district, where the ferriferous rocks are present.

These rocks are not covered with any other rocks between Little Falls and Oneida Creek.—Being the highest rocks there, they are conveniently inspected, and afford ample compensation for the labour of an examination. A little west of Oneida Creek they pass laterally under the elevated country south of the canal, through which the stage road passes; but they are just at the bottom of the canal as far as Clyde, about eighty miles farther west. We may therefore consider the iron formation as the uppermost underlaying strata of most of the great swamp from Rome to Clyde, a distance of about one hundred miles.

The whole thickness of the iron formation at Genesee Falls is thirty-eight feet. Here the iron ore is but about one foot in thickness. In most of the ore beds which are wrought, the ore is from twelve to twenty inches in thickness. In several localities I have seen two or three beds in succession, alternating with layers of the sand rock;—rarely with those of the slate rock.

The best ore beds (or, perhaps, more properly, the best parts of the great stratum of argillaceous iron ore) which are at present wrought, are between Little Falls and Oneida Creek, on the south side of the canal, and between Lyons and the Genesee River, on the north side. West of Genesee River, the iron formation is chiefly on the south side of the canal as far as Lockport. There the canal turns very suddenly to the south, leaving the eastern face of the great offset, wherein several secondary rocks are exhibited, on the north. This offset crosses Niagara River, at Lewiston, leaving the great falls six or seven miles south.

18. Ferriferous Slate. [Vid. Def. p. 36.]

This is the lowest of the ferriferous rocks. It is very soft, and in fissile scales, or brittle irregular laminæ, which readily dissolve into tenaceous clay soil. In many localities it is a beautiful green; and always blue or green, or an intermediate colour. It is sometimes almost as hard as transition argillite; but it is generally much softer. In the bottom of a well in Salina, at the upper part of the village, forty-three feet deep, it presents a very singular structure. The surfaces of the layers, which are about half an inch thick, are marked with angular grooves so arranged as to resemble the midribs of leaves with lateral secondary ribs and veins. These appearances are undoubtedly the effect of a crystaline tendency. They may be compared with the crystals of frost on a glass window. Certainly they are not vegetable impressions, as imagined by some gentlemen in the village; for

they are destitute of that curvilinear structure which is inseparable from vegetable growth.

This rock is to be seen at frequent intervals from Little Falls to Oneida Creek; then not unfrequently to Clyde; and in the channels of creeks, ravines and the like, quite to Niagara River. It is in view at the foot of the hill east of Chittenango Creek, and in all places about as low, for several miles in that vicinity. It appears cropping out with the other secondary rocks, from near Little Falls to Lake Ontario. The canal cuts across it seven or eight miles west of Genesee River, and it appears a short distance a little east of Lockport.

The thickness of this rock is somewhat variable. At Genesee Falls it is twenty-three feet thick; perhaps this is near an average, though it is but about ten feet at the iron mines in Verona. It runs along about two and a half miles south of Lake Ontario, from the Irondiquot Bay to Sodus Bay.

19. Ferriferous Sandrock. [Vid. Def. p. 36.]

Though this rock is a kind of colleague with the ferriferous slate, in supporting and enclosing all the iron ore beds of the canal district, perhaps no two rocks are more unlike each other. While the rock just described is a very soft argillaceous slate, this is a hard silicious rock, which breaks into thick formless or square-faced blocks. In some places the two rocks alternate with each other, but generally they are separated by a continuous layer, or extensive bed, of argillaceous iron ore. At Genesee Falls, the sandrock is fourteen feet thick, and the slate rock twenty-three. These are very near

the relative thicknesses of the two rocks in the banks of the Niagara River also; whereas at their out-croppings near the Mohawk, and wherever their full thickness is in view almost to Vernon, the sandrock is from five to ten times the thickness of the slate.

All the hills between Little Falls and Oneida Creek, including that on which Hamilton College stands, are made up chiefly of the ferriferous sandrock. Those valuable iron mines in Westmoreland, Paris, Verona, &c. are mostly embraced in this rock. In some of the mines, the iron ore alternates several times with the rock, and often appears in irregular beds, differing in extent and thickness. In some places we find the ferriferous slate rock underlaying the whole; and in a few places, it alternates with the sandrock. All the varieties of both rocks in all positions, with the lenticular and jaspery varieties of ore, are best exhibited in Mr. Salmon Laird's ore bed, in the southwest corner of Westmoreland, eleven and a half miles west of Utica. Here I found marine and fresh water petrifactions, both in the ore and in the sandrock.

The ore bed on Dr. Norton's land, four and a half miles southwest from Utica, is on a hill of considerable elevation. In truth, all the iron mines are more and more elevated as they approach their out-croppings near the Mohawk. No rock overlays this between the top of the ridge, which it forms two or three miles south of the canal between Little Falls and Utica, and the Oneida Creek. Being a pretty good quarry stone, its accessible position renders it very convenient, and

much in use for various works. It is used in the abutments of the canal bridges; also for buildings in Utica, Whitesborough, New-Hartford, and other villages. Rounded masses of it are a great annoyance in the highways wherever it caps the hills, on account of its hardness and durability.

The ore embraced in this rock is more granulated, and has less the appearance of lenticular form, than that which is between it and the slate, or embraced in the slate. More of the jaspery variety is found in it; and sometimes the oxyd of iron is in a larger proportion compared with the alumine, than is found in connexion with the ferriferous slate rock.

Though this rock may be found within three miles of the canal on the south side, all the way from Little Falls to Utica, it is not seen in the canal banks east of Manlius. About half a mile east of Limestone Creek in Manlius, we begin to have a fair view of this rock, passing immediately under the calciferous slate, which embraces the gypsum, &c. Here at its surface, where it meets with the overlaying slate rock, it often passes into a kind of ferriferous breccia. Partly in this state, and partly in the well-formed sandrock, we see it passing laterally under the gypsum bed, near the Limestone Creek; which bed is embraced in the calciferous slate. From Manlius to Clyde, we see the upper side of this rock at intervals, often passing under the slate as just mentioned. Sometimes it manifests itself by giving a red colour to the gravel and loam in the canal banks. This rock occurs again from ten to twelve miles west of Genesee River, in the

banks of the canal. It appears in a thin half broken stratum, and often interrupted.

To form a correct opinion of this rock, it must be examined in the banks of Niagara River between the Falls and Lewiston, or at Genesee Falls. It should then be compared with the same rock in the hills of Paris or Westmoreland. It will be found, not only a much thinner stratum in the banks of these rivers than in the hills, but of a much softer texture. It is more inclined to a yellow or orange colour, from the oxyd of iron it contains, where it is exposed in the hills.

Being made up of quartzose sand, it produces a meagre silicious soil, unless it is compounded with the alluminous soil formed from the slaty rock beneath.

I apply the adjective, *ferriferous*, to these two rocks, because I can find no appropriate names for them. Two distinct rocks embracing argillaceous iron ore, which appear to be perfectly continuous for at least two hundred and forty miles, have not probably been examined by any European geologist. If small patches of similar rocks have been seen, they were probably too limited in extent to require a place in the generalization of rocks. The term ferriferous being strictly descriptive, it may be conveniently used as a part of the definitions, when competent authority shall give names to these rocks. Students in geology will therefore lose nothing by the temporary use of this descriptive appellation; for surely no one will doubt, that these rocks will ever hold their places in the system, on account of their vast extent and distinctness of character.

20. Calciferous Slate, (*or Second Graywacke, with Shell Limerock.*) [Vid. Def. p. 37.]

In this stratum, I include what have been described under *shell limestone*, *secondary gypsum*, and *secondary sandstone* and *slate*. I have seen European specimens which resemble every extensive variety, which I wish to include here. The reader will then, of course, be impatient to demand my reason for this innovation. My reason is a single one, depending on a fact which is easily verified or disproved. I assert, that this rock commences a little west of Oneida Creek, and continues uninterrupted twenty or thirty miles beyond the Niagara River; excepting where it is cut across by the channels of rivers and creeks. I assert, also, that all the gypsum and shell limestone (excepting the geodiferous and cornitiferous) of the canal district, exist in the state of limited beds in this rock.

To prevent all misunderstanding, it should be observed, that by disintegration, beds are often laid bare, and left in an insulated state. Parts of broken down gypsum and limestone rocks are often found surrounded by debris or alluvion; but wherever either of these rocks is found in place, it is always a bed of not very great extent. It follows, then, that the slate rock under consideration is the only one of this connexion which can be set down in a system as a continuous stratum. The two limerocks above this, (geodiferous and cornitiferous) are continuous and independent; therefore I treat them as distinct strata. Though this statement is made in a few words, I spent about forty days, and travelled more than one thousand miles, before I

satisfied myself in regard to its correctness; and I had gone through more than three-fourths of the labour, before I even suspected that I should ever feel authorised to treat the shell limestone and gypsum as mere beds in this slate rock.

It is not probable that those learned and indefatigable Europeans, who treat these beds as holding their independent ranks in the system, ever saw them on such an extensive scale. We have beds of shell limestone, perhaps a mile or two, or more, in length. This would be considerable in a limited district, like many of those which form standard localities in Europe. But the conceptions of those geologists would be very different, if they should see these beds begin and end, ten or twenty times, at various heights, in a continuous slate rock two hundred and twenty miles in extent.

After I had seen the shell limerock, of most importance and most known, terminated on all sides so as to prove it to be in beds, I began to question the propriety of ranking that rock as an independent stratum. The gypsum being manifestly in beds also, I set about fixing the limits and definitions of the rocks to which they must be referred as subordinates. Having generally found the gypsum imbedded in a more fissile and softer slate than that which embraced the limestone, and situated beneath it, I imagined I might establish a *gypsiferous* stratum, and a *calciferous* stratum. This I communicated to several gentlemen on the canal route, and conversed much on the subject with my assistants, Messrs. Webster and Eights. I was at length so fortunate as to visit one of the most im-

portant localities, with Prof. Joel Nott, of Union College. We commenced at Limestone Creek in Manlius, and crossed the range in a south direction. Immediately on the ferriferous formation, we found this slate; then a bed of gypsum, terminating east and west in the bank of the canal; being eight or ten perches in length. Above the gypsum, the slate is continued to about the thickness of sixty or seventy feet. Then an extensive bed of shell limestone occurs, ten or twelve feet in thickness, and perhaps from half a mile to a mile in breadth. Then the slate again, embracing a bed of gypsum of much greater extent than that in the immediate bank of the canal. This last mentioned slate, with its bed of gypsum, terminates the hill upwards. Having examined this hill easterly to Chittenings Creek, and sufficiently on all sides, it appeared that the slate could not be separated into two strata. I was very happy in having my opinion confirmed by that of Prof. Nott, that there would be much propriety in calling this vast slate rock by the general name, *calciferous slate.* For it not only embraces numerous beds of other rocks, whose bases are lime; but it often, and, in truth, generally, contains fine grains of carbonate of lime, sufficient to produce considerable effervescence with acids.

In the brow of the hill at Manlius, particularly a fourth of a mile east of Limestone Creek, there is a very peculiar variety of limerock. As I had seen the same rock at Syracuse, Auburn, Canandaigua and other places, in nearly the same relative position, we examined it here with particular care. It is a dark-grey or blue rock, perforated every where

with curvilinear holes; but very compact between the holes. We found several holes which were still lined with a kind of tubular calcareous shell or crust, in some measure resembling the tubular covering of the serpula, which is so often seen perforating coral rocks. As this rock is sufficiently extensive to be entitled to the rank of a subordinate rock, Prof. Nott considered *vermicular limerock* as an appropriate name.

Besides the three subordinates, shell limestone, vermicular limestone and gypsum, already mentioned; the silicious variety of limerock, called *water limerock*, has recently come into notice. On being burned, in the same manner in which common limestone is burned in the manufacture of quicklime, then pulverized and made into a paste; this paste is used in mason work which is to remain under water. It soon becomes a firm hard cement. It has been used in laying all the western locks in the canal. It seems to vary greatly in its constituent parts. Quartzose and carbonate of lime grains, finely comminuted and united by adhesion, not by chemical affinity, seem to be all that is essential. It often contains other substances, but they appear to be accidental. In some places it passes into a porous, cellular, sponge-like rock, and contains scarcely any carbonate of lime. It then generally abounds in petrifactions. The localities of the water limestone are very numerous. I have seen it at intervals from near Oneida Creek to Palmyra; also at Ellicott's Mills, on Oak-Orchard Creek. The principal manufacture of it is on Chitteningo Creek.

The calciferous slate is remarkable for the daily production of mineral substances, by the decomposition and combination of its own constituents. Messrs. Webster and Eights found epsom salts formed and forming on the east bank of the Genesee River, at the top of the lower falls. We afterwards found, that the production of epsom salts, alum, and copperas, was very common in this rock every where. Stalactites of carbonate of lime, from the fourth of an inch to two or three inches in length, are very common on the under surfaces of its thin slaty layers. Vast beds of calc tufa are produced from it also. Large quantities are to be seen in the banks of the canal in Manlius, near Salina. At Ellicott's Mills, the process of forming the tufa is now rapidly going on. Many tons of this new-formed rock are now suspended from beneath the layers of the slate; and their volumes are daily increasing by successive deposites.

The most remarkable deposite of the calc tufa which has ever come to my knowledge, is near the head of Otsquaga Creek, a little above Brown's Mills. It proceeds from the slate rocks, which are either the upper layers of graywacke, or the calciferous slate. They precisely resemble the latter rocks, but do not contain similar beds. The calc tufa which proceeds from these rocks, contains the impressions of numerous plants of the same species which are now growing in the vicinity. Both here and at Ellicott's Mills, I collected specimens which were partly stone, and partly moss still in a growing state. There is a single mass on the bank of the creek, about three hundred feet long, fifty wide,

and from ten to forty feet thick. It is very irregular in its form: near its north end it is cavernous. Several rude apartments may be entered, which present curvilinear sides, and irregular conical columns. At the southwestern termination of this extensive deposite, about a mile south of the caverns, there are the tufa petrifactions of six logs, which stand obliquely against a side-hill. They are very perfect yet, (not having been often visited) even retaining the forms of the shelly scales of the bark, the knots, &c.

The thickness of this stratum is variable. Along the south side of the canal, from a little west of Oneida Creek to Palmyra, it is generally from one hundred to two hundred and fifty feet thick. Its northern side may be conveniently inspected throughout most of this extent. At and near Limestone Creek in Manlius, it may be examined at the bank of the canal. Excepting a few insulated patches, and one pretty large field of it at Adams' Mills and the hill west, in the town of Wolcott, several miles north of Clyde, this stratum seems to be chiefly confined to the south side of the canal. It forms and underlays most of the elevated ridge on which the stage road runs, including the villages of Skaneateles, Auburn, Cayuga, Geneva and Canandaigua. Most of the way it is the highest rock. It is overlayed with the cornitiferous limerock near the State Prison in Auburn, and in some other places. At the east end of Auburn village, the pyritiferous slate seems to cover it. It appears on the canal at Windsor village; at the three or four lower locks at Lockport, and from the bottom of

the stair cases at Niagara Falls, covered with the debris of the geodiferous rock.

This rock lies immediately upon the metalliferous limestone at East-Canada Creek, seven miles north of the canal. Here it effervesces strongly with acids. It seems to occupy the same relative position between the spurs of gneiss, which graywacke does east and west of them. On the south side of the canal, where it is marked on our section, it embraces shell limestone, which contains numerous petrifactions. It will be perceived, that wherever this rock appears east of Little Falls, several rock strata are wanting beneath it. Between it and the metalliferous limestone, for example, there is a deficiency of graywacke, millstone grit, saliferous rock, grey band, ferriferous slate, and ferriferous sandrock.

In some places this rock passes immediately under the cornitiferous, or cavernous limerock, as at Auburn State Prison. After running several miles up Cayuga Lake, it passes under the same rock. But from Pittsford to Rochester, it passes under the geodiferous limerock; also at Lockport and Niagara Falls. Wherever the latter rock is present, it always reposes immediately on this. Wherever this rock has become extensively disintegrated, we find its imbedded subordinates among the alluvion. For example, the gypsum beds on Cayuga Lake, between Spring Mills and the stage road, lie in detached blocks, &c. upon the iron formation, intermixed with the debris of the calciferous slate. Immediately adjoining Spring Mills, the proprietor, Mr. W. Burling, shewed me an al-

luvial bank, which is made up of minute fragments of gypsum and slate.

This rock bears such a resemblance to graywacke slate, that it may be called second graywacke; but its constituent pebbles are more rounded than in graywacke slate. It differs from graywacke, too, in being chiefly destitute of those shining scales which are found in graywacke slate; but above all, it differs essentially in its connexions. The vast beds of gypsum and shell limestone which it contains, are never found in graywacke. The kind of petrifactions, too, are mostly unlike those found in transition rocks. The horn-shaped madreporites, from four to ten inches in length, abound in the limestone beds in this rock, on the shores of Skaneateles Lake, in Canandaigua and other places. The bivalve shell animals are more recent and perfect.

If this is the same rock which embraces shell limerock near Schoharie-Kill, south of the canal, it embraces the new Schoharite variety of blue fibrous sulphate of barytes; also satin spar, of an oily colour, resembling carbonate of barytes. It is said that Dr. Fenn, of Geneseo, found sulphuret of lead in it, near Rochester. Epsom salts, alum and copperas, have been mentioned in a former page.

This rock, with its numerous imbedded substances, in disintegration, forms the best of soil. The country which it underlays, is in all respects one of the most valuable districts in North America. The rock is so extensive, and so multifarious in its characters and connexions, that but a very general outline could at this time be expected. The sci-

ences of mineralogy and geology are now making such rapid strides in our country, that this outline will undoubtedly be soon filled up by those who reside in its immediate vicinity.

21. Graniferous Limerock, (*or Swine-stone.*)
[Vid. Def. p. 33.]

The name swinestone alone would have been applied to this rock, thereby avoiding a new name, if that name had not been applied to other minerals. It seems to have been applied to every variety of carbonate of lime, which gives off any kind of odour on being struck or scraped. The odour produced with the rhombic spar of Berkshire county, Mass. and with all other primitive limestone, denominated fetid limestone or swinestone, which has come to my knowledge, bears no resemblance to this. Their odour is unquestionably more analogous to that produced by striking together two pieces of quartz, or by moistening argillite with the breath; whereas this rock gives off a kind of odour peculiar to animal matter. When kilns of it are burning for the manufacture of lime, the smell of burning leather or horn is perceived at a great distance. On being scraped or struck, it gives off an odour resembling that of a horse's hoof, when pared by the smith for shoeing.

I believe this rock has never been ranked among independent strata, in any system constructed for generalizing rocks. This fact proves that it has not been hitherto examined in any country, where it is so extensive, so uniform in its characters, and so independent of all other rocks, as in our district.

It commences in the canal line about four or five miles east of Genesee River. The canal is cut through it about half a mile east of the river. Being cut off by the river, it recommences on the west side of it; and then winds away south with the other secondary rocks above the red saliferous, leaving the canal to the north. At Lockport, where the canal ascends the mountain ridge, it is cut through this rock, to the depth of thirty feet, for two miles. It then continues to Niagara Falls, leaving the canal to the south. I have no doubt but it underlays the canal, below the alluvion, for a considerable distance farther than it can be seen. We can actually trace it along the range called Mountain Ridge, and the level country east of it, to the extent of more than one hundred miles. It always lies immediately upon the calciferous slate; and is the highest rock, excepting where it passes under the cornitiferous limerock. Besides its great extent as a continuous rock, it appears in patches and fields, in the same relative position as it respects other rocks, considerably farther east and west. It is in patches north of Lyons, and in several other places in that district. Prof. Silliman found it similarly situated near Montreal in Canada. Prof. Douglass, Maj. Delafield, and W. A. Bird, Esq. found the sulphate of strontian in the same rock on Strontian Island, and on others of the group of Put-in-Bay Islands, near the west end of Lake Erie. Probably all the strata beneath this, are the same at those islands as at Niagara River.

As Niagara Falls are much visited by naturalists, there is one of the best and most convenient loca-

lities for examining this stratum. At the bottom of the stair cases, this rock lies immediately upon the calciferous slate. The latter is almost concealed by the immense quantity of debris, which has fallen upon its oblique surface from the former. Its thickness upwards extends to the top of the falls, and considerable higher in some places. Here it presents its geodiferous character in a pre-eminent degree. In the geodes we find snowy gypsum, selenite, dogtooth spar, pearl spar, fluor spar, waxy zinc blende, sulphate of strontian, and quartz crystals. I found rather the best specimens on the Canada side; though both sides are very interesting.

Those who travel the canal, and do not wish to visit Niagara Falls, will find every character of this rock at Lockport. Where it meets the calciferous slate among the locks, many curious petrifactions have been found. I saw there turbinites, pectinites, gryphites, isidites, &c. Dr. G. W. Palmer gave me most perfect asterites and encrinites, which he found there. About a mile and a half west of the locks, in the banks of the canal, is the best place for studying the characters of this rock. In addition to the embraced minerals just mentioned, and those found at Niagara Falls, here we find a petrifaction, to me anonymous, as I have seen no description of it. It has been called ligulite, from its resemblance to splinters of wood. It is made up of dark-brown groups or bundles of splinters, about two or three inches in length. These are always vertical, adhering laterally so as to form layers or strata from one to ten or fifteen feet in

breadth. Probably they are the remains of an animal of the class polypi of Cuvier, belonging to the coral family. But I am unable to make out its characters from Cuvier, Martin, Parkinson, or Rees' Cyclopedia; and I have no other authorities at hand. The same petrifaction, together with all the minerals contained in this rock at Niagara Falls and Lockport, are found in it where the canal is cut through on the east side of Genesee River.

The geodiferous rock is about seventy feet thick at Niagara Falls, fifty at Lockport, and thirty at Genesee River. A little above Niagara Falls, it passes under the cornitiferous limerock; being thus interposed between the latter rock and the calciferous slate, these rocks are separated from each other. But where the geodiferous rock is wanting, as in Auburn and many other places, the cornitiferous limerock reposes immediately on the calciferous slate and its subordinates.

Though this stratum is generally very pure carbonate of lime, mostly a dark-coloured formless rock; yet in many respects it resembles the grey silicious transition sandstone, which I have described under calciferous sandrock. They both contain geodes of quartz crystals, calc spar, and sulphate of zinc. This contains sulphate of strontian; that, sulphate of barytes.

What is called Mountain Ridge, is the north edge of another offset, nearly parallel to the red rock, or Ridge Road, offset. It is made by the termination of all the strata above the saliferous rock; as may be distinctly seen in the bank of Niagara River immediately south of Lewiston, by standing on the Canada shore. [See wood cut farther on.]

On disintegration and mixing with alluminous soil, it makes a compound scarcely equalled in fertility. Fifty and sixty bushels of wheat per acre are frequently obtained from this soil, without manuring, in Brighton on Genesee River, in some parts of the Holland Purchase, and other places which are underlayed by this rock.

22. Cornitiferous Limerock, (*or Second Shell Limerock.*) [Vid. Def. p. 37.]

Wherever this and the last described rocks are present, this is always uppermost. I have long been accustomed to consider secondary shell limerocks as belonging to the same stratum, whether they contain hornstone or not. But the canal rocks cannot be correctly described without removing those which do embrace hornstone in layers or beds, from those which are embraced in calciferous slate, and do not contain it in similar forms. I do not know that this distinction is a tenable one in other districts; because I had no time left for visiting other districts before winter set in, after I had ascertained the necessity of the separation in the canal district. I can recollect some localities which seem to authorise the separation, and others which seem to present obstacles to it. At any rate, this method is indispensably necessary in giving a description of the canal rocks.

The rock which gives name to the village of Black Rock, at the eastern extremity of Lake Erie, is a shell limerock, containing alternating layers of very dark brown hornstone. It underlays the whole village; though the pyritiferous rock is sometimes

seen lying over it in patches. Back of the garden of W. A. Bird, Esq. under the site of one of the fortifications which was thrown up in the last war, the pyritiferous rock overlays the cornitiferous. With a few such exceptions, this is the immediate underlaying rock throughout the village. It forms the only underlaying rock at the east end of Lake Erie for many miles, and perhaps throughout the whole extent of the lake. Bird's Island consists wholly of this rock; and it forms a naked flat rocky shore, at intervals, to a considerable distance west of Fort Erie, on the Canada side. It may be traced, by inspecting it at intervals, along the bed and banks of the Niagara River, to a little distance above the Falls, where the geodiferous limerock passes under it.

Wherever this rock lies immediately upon the calciferous slate, we may suppose the geodiferous rock wanting, and still consider this an independent stratum, distinct from the shell limestone embraced in the slate below it. It is the only continuous limerock stratum of the canal district, and the only one in which I found any hornstone in layers. It is the most cavernous of all rocks. Near the west side of Schoharie-Kill, about twelve miles south of the canal, are several vast caverns in this rock. A pretty large stream in Carlisle is lost in it for two or three miles. Bethlehem caverns, twelve miles south of Albany, are in this rock. It is somewhat cavernous in Camillus, south of Jordan; also at Auburn, near the State Prison. The springs at Spring Mills on Lake Ontario, are supposed to find their way from Owasco Lake through the caverns

and broad fissures in this rock. It is not in view at the mills; but it passes under the pyritiferous rock in fair view, several miles up towards the head of Cayuga Lake.

It contains numerous petrifactions. I have seen in this rock encrinites, entrochites, anthocephalites, chamites, gryphites, terebratulites, orthocerites, volutites, turbinites, common madreporites, retiporites, horn-form madreporites, favosites, isidites, alcyonites; all of which were labelled at my request by Le Sueur. Many of these petrifactions are entirely of hornstone.

The numerous alternating layers of hornstone embraced in this rock, render it very durable. Probably this is the cause of the shallowness of the waters of Lake Erie, compared with the other lakes. If the Falls at Niagara are yearly receding from Lake Ontario, according to the general opinion, their progress will be considerably checked when they encounter the hornstone layers in this rock, which is not a great distance above the Falls. The immediate rock at the Falls, the geodiferous limerock, presents the visitor with such immense quantities of debris, that it is very natural to anticipate the rapid retreat of this precipice.

Cuvier is unquestionably correct when he says, there have been great changes on this earth—and that life has often been disturbed by terrible events. But our fancies are often too exuberant in supplying the deficiencies in matters of fact, when we would account for phenomena. The drudgery of collecting facts at a slow pace, is iron fetters to a brilliant fancy.

23. PYRITIFEROUS ROCK, (*or Third Graywacke, with Shell Limerock.*) [Vid. Def. p. 38.]

Though this is asterisked under geological nomenclature among the six proposed names, it is not strictly a new name. A similar rock at Whitby, and near Charmouth, in England, is called *pyritous shale* by some of the English geologists. For the sake of uniformity, I changed pyritous to pyritiferous. I change shale to rock, because our stratum is not always of a slaty form. The pyritous shale of England contains great quantities of iron pyrites, and frequently embraces beds of bituminous and sulphurous coal. It is stated on high authority, that when masses of this rock fall from the cliffs at Whitby, and become moistened with sea-water, they take fire and burn spontaneously. It is also asserted on the same authority, that tremendous explosions take place in mines dug into this rock; which are now known to be the explosions of sulphuretted hydrogen gas, which is produced by the decomposition of water through the agency of the iron pyrites.

The same rock in our district embraces thin beds of bituminous and sulphurous coal. Between two and three miles down the Cayuga Lake from its head in Ithaca, in the east bank, about forty-five miles south of the canal at Montezuma, I saw a bed of this kind of coal, from the fourth of an inch to a full inch in thickness, embraced in this rock. It may now be traced in the naked precipice for ten or fifteen perches. Mr. Gideon Phelps gave me specimens taken from this rock in the east bank of Owasco Creek at Auburn, among which I found

the same kind of coal in very thin masses. Dr. Hays, of Canandaigua, found similar beds of this coal five or six miles from that village, in this rock also. In truth, I am satisfied from what I saw in place, and from the numerous specimens shewn me, that those thin layers of coal are very common in this rock, throughout a great extent of country. As coal beds of sufficient extent for working to great profit, are often found in this rock in the eastern continent, the inhabitants of such districts here should take notice of all appearances of coal; more particularly, as we do know that the rock contains thin beds of the very same variety of coal which is contained in it in England.

In regard to the sulphuretted hydrogen gas produced by the iron pyrites embraced in this rock, ours certainly resembles that of Europe. A mile south of Niagara Falls, at the west side of the river, hydrogen gas issues from the bank; which appears to consist mostly of this rock, covered with soil. On several trials by the watch, I judged that about five quarts might be collected every minute. It is said to give off a little more at some seasons than at others. I took my measures on the 14th of August, 1823. The same gas issues almost in an equal quantity near the head of Otsquaga Creek, from a rock greatly resembling this; but it seems to be one of the highest layers of graywacke. See reflections upon this rock at pp. 88 and 89. The gas issuing at both these places, burns with a flame perfectly resembling that of the artificial sulphuretted hydrogen gas.

All those thin beds of coal lie in a horizontal po-

sition, between layers of the rock. I saw two and three of those beds in succession, one above another, separated by layers of the rock, from one inch to four or five feet in thickness. Therefore if any accident should disclose a thick bed of coal in this rock, it might be well to bore for other beds beneath it. But I should doubt the probability of finding one of these thin beds terminating very soon in a thick one, on following it laterally between the layers of rock.

All the thin coal beds which I examined in this rock, were embraced between thin layers of iron pyrites. Wherever these were exposed, the adjoining rock was more or less covered with copperas, alum, and epsom salts. The ledges containing these substances were perpetually crumbling down, and all beneath the coal beds was every where stained with these salts.

Though this rock is distributed over a large area of the western part of the state of New-York, it is often interrupted by valleys, lakes, beds of rivers, and ravines. Being very easily dissolved on exposure to the common disintegrating agents, rapidly decomposed by the laws of elective affinity, and being the uppermost stratum known in our country, it has of course passed away at frequent intervals, leaving the naked stratum beneath in full view. Though it appears within a few miles of the canal in several limited patches west of Onondaga salt springs, I can recommend no place to the student within fifteen miles of it. To obtain a knowledge of all its peculiarities, the student should examine the two following localities. From Fall

Creek, a mile north of Ithaca village, to where the cornitiferous limerock appears on the east shore of Cayuga Lake, nearly at a level with the waters of the lake. This four mile walk will bring into view most of its characters, including the coal, alum, copperas, and epsom salts already mentioned. The other is on the south side of Lake Erie, between fourteen and twenty miles west of Buffalo village. About three miles east and three west of the mouth of Eighteen-Mile Creek, will be sufficient for examination.

Where this stratum rests upon the underlaying rock, it is a very brittle scaly slate. It does not materially change this character, until we ascend the ledges from fifteen to twenty-five feet. There we meet with graywacke-like square-faced blocks, and sometimes with ranges of blocks of limestone. In some localities the upper layers are very pure limestone; in others they are a kind of alluminous limestone. Generally the soft slate is intermixed with the limestone, or alternates with it. The stratum is about two hundred and twenty feet thick at Fall Creek in Ithaca, and about fifty feet thick on the bank of Lake Erie.

At Ithaca Falls, a channel of great depth has been cut through the south bank, for a water course. The high banks of this channel are made up of square-faced blocks, which appear to be excellent building stone; but on trial, it is found that the great quantity of fine granulated iron pyrites contained in it, causes rapid decomposition, while a strong sulphurous odour is continually given off. About two miles north, on the east bank of the lake,

the pyritiferous character of the rock is strikingly manifest. Here the perpendicular ledge is about fifty feet high. Most of the rocks are filled with minute grains of iron pyrites; besides having nodules of the same, from the fourth of an inch to an inch in diameter, every where disseminated in them. Vast heaps of the broken down rock, blackened with the decomposing and decomposed iron pyrites, and giving off a strong sulphurous odour, appear along the lake shore under the ledge.

About two and a half miles north of the head of the lake, we may see the cornitiferous limerock passing under the slate. Their meeting may be seen at several other places on both sides of the lake. But from the best evidence I could obtain, I am inclined to believe that there are limited fields about Auburn, Canandaigua, and other places, where this rock lies immediately on the calciferous slate; but I found no decisive locality.

On the south shore of Lake Erie, we see this rock, from its southeast corner in Hamburgh, eight miles from Buffalo, with very little interruption, to Sturgeon Point. It appears from the travels of Engineer D. Thomas, that the same rock borders the lake to Cattaraugus Creek, and probably much farther. We see little but the shelly, rarely exceeding twelve feet in height, until we come within about three miles of Eighteen-Mile Creek. On both sides of this creek, as was before stated, the rock is very similar. The loose scaly slate occupies about twenty-five feet of the lower part, and the ranges of square-faced blocks of limestone occupy about the same number of feet above—frequently interrupted with the slate.

The slaty part is remarkable for furnishing most perfect petrifactions. Being very soft, the petrifactions either fall out, or may be detached with the fingers without breaking or wounding their most delicate parts. We collected several dozen petrifactions in about as many minutes. The upper part of the ledge is equally rich in organic remains; but it often requires careful chiselling to disengage them from the rock. We did not collect many different kinds. The chief were, a sub-species of anomite in great abundance, favosites, horn-form madreporites, encrinites, entrochites, pectinites, anthocephalites, cardites, orthocerites, turbinites, trilobites, and milleporites. The milleporites were yet white, and had all the recent appearances of the present branching coral rocks of the ocean.

No subject appertaining to this stratum was so interesting to me, as the iron pyrites connected with the limerock. It is mostly attached to the under surfaces of the layers, in a stalactitic or mammilary form. It is a bright golden yellow, embracing immense quantities of petrifactions. The petrifactions are sometimes but superficially covered with the pyrites; though vast quantities of them may be found, which consist wholly of this ore. The story of an old lady whom we had met on the beach, that we should find golden clams in the ledge, seemed almost a reality. We collected masses of minute pyritic anomites, in which many dozens are embraced within a few solid inches.

I found a petrifaction of the horn-form madreporite in this stratum, in which it exhibits conclusive evidence that each joint is a distinct animal, joined

to the proceeding in a proliferous manner, like the leaves of the prickly pear. Whether the oldest animal is at the apex or base, does not appear certain; but that at the apex is probably the oldest.

The slaty part of this stratum embraces numerous globular concretions, consisting chiefly of a kind of wacke. On breaking a great number of these concretions, which were from an inch to a foot in diameter, I found that they all contained some kind of nucleus, differing from the enclosing matter. The nucleus is frequently the irregular fragment of a petrifaction, most commonly of a stylastrite. Sometimes it is a fragment of limestone, very unlike that variety which is connected with this stratum in layers.

This stratum is not interrupted by any other rock from near the meridian of Onondaga Salt Springs to Lake Erie, a distance of about one hundred and fifty miles. It may be considered as almost wholly on the south side of the canal, from five to twenty-five miles distant. Though it is not interrupted by any other rock, nor covered by any, it is often interrupted by lakes, rivers and valleys, as before stated.

Its disintegration is very rapid; but I am not well informed in regard to the soil it produces. I made considerable enquiry respecting it, but obtained no decisive information. The soil probably contains about a due proportion of alluminous and silicious materials; and the intermixture of limestone is favorable to its richness. What effect the immense quantities of iron pyrites have upon vegetation, requires farther observation.

IV. SUPERINCUMBENT CLASS.

[Vid. Def. p. 38.]

24. AMYGDALOID, (*or Basalt.*) [Vid. Def. p. 38.]

As both rocks in this class are wholly wanting in the canal district, but little room will be given to them. To say what American rocks are wanting, appears to be necessary in giving the geology of such an extensive district.

The rock marked greenstone trap, near Connecticut River in our section, rests upon the amygdaloid. It may be said of most of the American localities, that the amygdaloid underlays that rock. Generally it lies upon the old red sandstone, or perhaps the conglomerate kind of saliferous rock. Those who treat the superincumbent class as volcanic rocks, find testimony, at least plausible, in this rock. Specimens of it may be found in great abundance, which cannot be distinguished by the eye from the slag of forges.

All the varieties of this rock may be found in the southwest end of Mount Holyoke. Its localities may be understood to be given in the description of the next rock, which it always accompanies. Some localities are more prolific in minerals than others. Mr. Hitchcock found in this rock, at Deerfield on Connecticut River, a little north of our section, chalcedony, analcime, chabasie, stilbite, zeolite, agate, sardonix, prehnite, &c. These mi-

merals are generally contained in ballate or vermicular cavities. Fragments of this rock, on exposure, part with most of these minerals, and afterwards exhibit the appearance of worm-eaten logs.

25. Greenstone Trap, (*or Newest Flatz Trap.*)
[Vid. Def. p. 39.]

Suppose this rock to have once been a continuous stratum, from the north part of the state of Massachusetts to New-Haven in Connecticut. Then suppose a great proportion of this rock should pass away by disintegration or otherwise, leaving detached formless masses at irregular intervals. This would produce just such a series of greenstone trap hills and mountains, as we now see in that district.

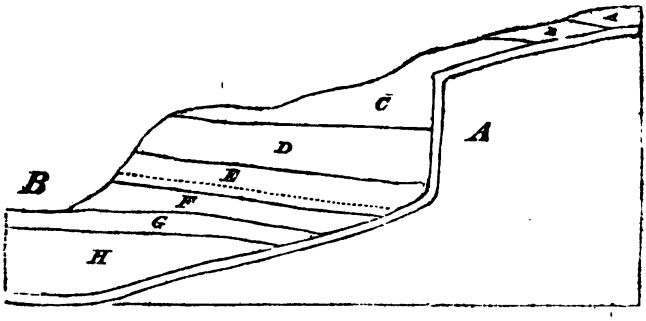
The same rock constitutes the well-known Palisadoes, on the west bank of the Hudson, below the Highlands. These latter rocks have been fully described by Dr. Akerly, Mr. Pierce and others. Mr. Hitchcock has also given an ample history of the trap rocks of the Connecticut River range. The polyhedral columns at Deerfield, in Mount Holyoke, and in the Palisadoes, should be visited by every American geologist. See Geological Index.

It has been asserted by some geologists, that we have no basaltic rocks in North America. We are required to yield implicit assent to this declaration, because it has been asserted by some persons who have seen basaltic rocks in Europe. I have seen three joints of basaltic columns from Giant's Causeway, and specimens from several other places in Europe, which are considered as standard localities. I have compared them with our basaltic, or

superincumbent rocks, not only by the eye, but by all the given tests. I can discover no difference between the foreign rocks, and specimens which I select at the west end of Mount Holyoke. Surely we may select specimens here which differ from any European specimens that I have seen; but we can find the same difference between parts of the same rock here, not twenty feet distant from each other. In comparing our basaltic rocks with those of Europe, it should not be forgotten, that the minerals disseminated in those of both countries are generally the same.

NIAGARA FALLS,

With the rocks in the east bank, from a little above the Falls, to Lewiston.



Double lines, the bed of the river.

A—the pyritiferous rock.

B—the cornitiferous limerock.

C—the geodiferous limerock.

D—the calciferous slate.

E—the ferriferous sandrock, with a red fillet of iron ore at its lower surface.

F—the ferriferous slate.

G—the grey band.

H—the saliferous rock.

A—the falls, 150 feet.

B—Lewiston.

Note. The pyritiferous rock will not be found in fair view here; but it is very perfect from eight to eighteen miles west of Buffalo, on Lake Erie. The cornitiferous rock is most perfect at Black Rock.

HILLS AND VALLEYS.

If we suppose our primitive rocks to be the most elevated at their out-cropping edges, while the transition and secondary rocks are less and less elevated as we recede from the primitive range, and that they are all nearly co-extensive, though not all in view, we shall accommodate our views of them to the Wernerian system of arrangement. There appears to be nothing in our district at variance with the general outline of this scheme, if we study and compare attentively the rocks which underlay our hills and valleys. I believe that all the important hills and valleys in our district may be shewn to have originated in the different texture of the rock strata. We will suppose the surface of our district to have been originally a regular inclined plane, from Savoy in the Green Mountain range of gneiss, to the south shore of Lake Erie. We will now leave out of view the iron, salt, and coal formations adjoining the canal—keeping our view about twenty miles north of the north line of Pennsylvania, and crossing Catskill Mountains.

The first interruption in our inclined plane, is in the range marked Adams in our section. Why does this deep abrupt valley occur so near the high primitive range of gneiss, hornblende rock, and granular quartz? The answer is not conjec-

tural, but certain. This valley is underlayed by granular limerock. If its out-cropping edge was once as high as that of the gneiss, being subject to both disintegration and chemical decomposition, it would have so far outrun the gneiss in the race of dissolution, as to form a valley by its side. A little south of our section we have a distant view of Saddle Mountain, rising abruptly west of Adams valley. This mountain is chiefly gneiss, granular quartz, and other durable rocks. At Williams College is a return of the limestone, and on it an extensive valley.

The mountain range west of Williams College is chiefly the oldest and most durable kind of primitive argillite. The deep narrow valley of the Little Hoosick is upon sparry limerock. West of this valley, the Petersburgh Mountain is capped with the hard rubblestone variety of graywacke. As we approach the valley of the Hudson, we find the ruins of once continuous strata, which are subject to rapid disintegration; such as soft graywacke slate, metalliferous limestone, and soft transition argillite. The brow of the hill a little east of the Hudson, is still defended by a range of calciferous sandstone. If we incline a few degrees to the south, we see the Catskill Mountains rising to a great height. On examining their upper rocks, we find them to be chiefly the hardest kind of rubblestone graywacke, and very hard old red sandstone.

If we extend our examinations in all directions, I think we shall find the same law every where giving rise to hills and valleys. But there are some deep narrow chasms which cannot be explained in this

way; such as the chasm through which the Hudson passes in the Highlands, and through which the Mohawk passes at the Little Falls.

The beds of *rivers* and *lakes* are but valleys, ravines, or chasms; and must have originated in the same manner. Waters often wear their original beds deeper, or break down their confines and change their courses. But we are compelled to admit that hills and valleys were formed first, and that afterwards water began to descend the inclining sides of the hills, and to collect or march onward through the valleys. The Hudson has its bed at the western margin of the softest variety of argillite, just where the hardest variety of graywacke commences, most of the way from Fort Edward to near the Highlands—a distance of about one hundred and fifty miles. Salmon River, which flows into Lake Ontario, the west branch of Fish Creek, and the Mohawk almost to Little Falls, coincide with a natural and continuous geological boundary. They follow the southwestern margin of a soft variety of graywacke slate, just where the millstone grit, ferriferous sandrock, and other hard rocks commence. After passing the Little Falls, the Mohawk follows the southern limits of the limestone and sandstone, which skirt the primitive spurs from Macomb's Mountains; while on the south side of it, the hard graywacke, in subsiding ridges from Catskill Mountains, terminates more or less abruptly for a considerable distance.

Lake Champlain is at the western termination of the transition, and perhaps secondary, rocks of Vermont, and at the eastern side of the primitive

rocks of Macomb's Mountains. Lake Ontario stretches along the northern margin of the soft saliferous rock of the canal district.

From these, and numerous other cases which might be cited, it is manifest that great rivers and lakes, whose beds are circumscribed by rocks, often form important geological, as well as geographical boundaries.

PECULIAR FORMATIONS;

CAUSING DIFFERENCES IN GEOLOGICAL NOMENCLATURE.

It is suggested in the Supplement to Rees' Cyclopedia, that the British geologists were merely engaged in looking for German rocks in Britain, until Bakewell ventured to look at British rocks as such. We may with equal propriety say, that American geologists, with few exceptions, have been engaged in looking for German, French, and British rocks, to the exclusion of our own.

Nothing is so desirable to an American geologist, as to be able to identify the rocks of the eastern continent with those of our own; and he may go farther in this science with success in that particular, than in any other department of natural history. But if transition trap, primitive silicious slate, primitive gypsum,* and the chalk basins of Europe, are not to be found in America, shall we make ourselves ridiculous in our own estimation, by insisting on their presence, and by giving them their allotted places in our systems? Or shall we exclude from our list of rocks our vast iron formation, because similar rocks have never been found in the eastern continent, excepting a few limited patches or beds?

* See Maclure's Letter, Silliman's Journal, Vol. I. p. 211.

We should delight to find a chalk basin in our secondary district, with all the interesting contents of the Paris basin, described by Cuvier and Brongniard. But we have no chalk in North America; consequently we can never expect to find those interesting substances, which figure so admirably in European treatises.

I have a learned and valuable friend, who stands among the highest list, and who understands every body's merit better than he does his own, continually urging me to treat our granular quartz and granular limestone as mere beds. As these rocks are thus treated in Europe, he supposes I may do the subject justice by describing them as very large beds. But if these are to be treated as subordinate rocks or beds, they must be subordinate to the mica slate, or talcose slate perhaps. In our district, they occupy at least ten times the area of both slate rocks. The question resolves itself as follows: Because these rocks are found in small beds in Great Britain, shall we make beds of those in our district, which occupy an area equal to one sixth of the whole island of Great Britain? Would not a student in geology be as much embarrassed at such an arrangement, as the student in geography at seeing the continent of America set down as a petty island, included in one of the sea-board counties of England? However we may have degenerated from the original stock of our ancestry, even Buffon would be obliged to admit, that our granular quartz rocks still hold their heads at mountain heights, excepting interrupted intervals, for three or four hundred miles in a north and south direction.

American geologists differ considerably on the subject of naming our hornblende rocks. Maclure does not yet give a decisive opinion; but he excludes from American rocks so many of the European subdivisions, that he seems upon the point of admitting but one stratum of hornblende rock, besides the superincumbents. Mr. Hitchcock, who has given much attention to the New-England rocks, still retains numerous subdivisions of this rock. He is very tenacious of European names, and is equally ingenious in compelling our rocks to submit to them. Probably no American is more competent to perform this work; and as the American nomenclature for primitive rocks is not well settled, Mr. H.'s views of them was considered of importance by Mr. Van Rensselaer. At his request, Mr. H. prepared the annexed profile and explanations.

Though Mr. H.'s section does not in all places coincide with the general one, there will be no difficulty in comparing all the important parts. From Worcester to Boston, they cross the same rocks. Mr. H.'s divisions are all included in what I consider as one indivisible hornblende rock, though it passes into numerous varieties. It is my opinion, that ten or twenty more subdivisions could be made with as much propriety as any one of these. And I assert, that I can shew many localities, where all those subdivisions can be seen in the same continuous layer of the same rock. By publishing Mr. H.'s section, Mr. V. R. furnishes the means of studying these rocks, without being subject to the views and speculations of individuals, who feel compelled to depart in this particular from European nomenclature.

REV. E. HITCHCOCK'S SECTION.

This section extends from Boston to the west line of Plainfield. It comprehends all the rocks with which I am acquainted, on a belt at least ten miles in width. Near the Connecticut, I have introduced some rocks from a greater distance than this. It is obvious by inspection, that the western part of the section is most perfect. In that part I have been able to assign to the several rocks their relative super-position. But in the eastern part, I have not facts enough to enable me to do this; and I have, therefore, separated the several formations by perpendicular lines. In the vicinity of Boston, I do not profess to be very accurate, not having examined the rocks there with sufficient attention. I only put down such as I have noticed in travelling over the ground hastily two or three times. But I trust Dr. Webster will supply my deficiencies, by sending you an accurate section from Boston to Worcester.* I have not been particular to lay off distances; but the names of the towns and rivers which are inserted, will mark out the situation of the rocks with sufficient accuracy. From the necessity of employing a double scale on such sections, it is well known that the true dip of the strata cannot always be exhibited. The following remarks (beginning with the rocks at Boston, and

* Dr. Webster generously volunteered in aid of Mr. V. R.'s object; but an accident happened which nearly cost his life, while he was engaged among those rocks. A. E.

proceeding westerly) will perhaps assist in understanding the section:

Sienite.—Dr. Webster informed me, that the only rock ever found in situ in Boston, was of this description.

Argillite passing into greenstone slate.—This occurs in Brighton, and sometimes becomes (so far as hand specimens enabled me to decide) real greenstone slate. The strata dip to the southwest.

Pudding stone.—Also in Brighton. This is the same as the Roxbury pudding stone. I do not pretend to say whether it be graywacke.

Amygdaloid.—I know but little concerning this rock, and may even be mistaken concerning its true place in the section.

Transition argillite.—This, as well as the stratum described above, belongs most certainly to the transition class of Werner.

Greenstone and sienite.—I include in these terms those rocks that have been sometimes called greenstone porphyry, sienite porphyry, epidote, and common greenstone, &c. It ought here to be remarked, that all the greenstone occurring in the vicinity of Boston, is very different in its appearance from the greenstone occurring along the Connecticut River.

Petrosilicious porphyry.—This is very similar to a rock of the same name occurring in Lynn, Malden, &c. and has similar associations.

Greenstone and *sienite.*—Same as that just described.

Diluvium.—I use this term as explained by Phillips & Conybear, in their last work on the geology

of England and Wales. It might with propriety have been marked in several other places on the map. By introducing the rocks occurring a few miles either north or south of Sudbury, it might have been excluded in this place.

Sienitic granite passing into sienite.—This stratum cannot be called sienite, I think. Much of it approaches nearer to true granite; and I am disposed to regard the whole as the rock which Dr. M'Culloch so well described by the name of sienitic granite. (Trans. Geolog. Soc. vol. III. p. 335.) If it graduates, as I am inclined from a hasty examination to believe it does, on the one side into pure granite, and on the other into transition sienite, it will not agree with some of the remarks made by that distinguished geologist upon these two rocks. In this rock, a few miles west of Sudbury causeway, I noticed a distinct vein of a dark compact greenstone. These veins are not uncommon in sienite and sienitic granite, in the vicinity of Boston.

Hornblende slate, becoming greenstone slate.—The hornblende slate passes into greenstone slate as one goes easterly. Some, perhaps, would denominate the whole hornblende slate. The layers are nearly perpendicular, and run nearly east and west.

Mica slate, often porphyritic and talcous.—The crystals of felspar vary from a mere line to more than an inch in diameter.

Granite.—This is described in the Index to the Geology of the Northern States.

Diluvium.—This stratum comprehends the valley in which Worcester stands.

Talcous slate.—This appears for a mile or two in passing west from Worcester.

Gneiss.—Sometimes beds of mica slate are interposed, and beds and veins of granite are very frequent, and often extensive. In Brookfield, I found abundance of precious garnet in this rock.

Mica slate with beds of gneiss.—In passing along the stage road from Northampton to Boston, little else appears in this part of the section, but mica slate; yet more northerly the gneiss is abundant.

Porphyritic granite.—This is a coarse grained granite, and is probably the same range that occurs in Winchester, Hinsdale, and in New-Hampshire. I cannot say whether it occurs in beds, or is fundamental.

Mica slate.—Sometimes containing beds of gneiss.

Gneiss.—Sometimes alternating with mica slate.

Hornblende slate.—I am in doubt whether I have given the true relative position of this anomalous rock. For a more particular description of this, and all the rocks hereafter to be mentioned, see American Journal of Science, vol. V. p. 1 to 86.

Sienitic granite. (M'Cul.)—Abundant in Belchertown and Ludlow.

Coal formation.—For a description of the varieties of rocks comprehended under this term, see Journal of Science, vol. VI. p. 61.

Greenstone.—See as above, p. 44.

Old red sandstone.—The greenstone forms a vast bed, so far as I can ascertain, between this rock and the coal formation.

Alternations of granite with mica slate.—The granite greatly predominates; but I am satisfied that it is in beds in mica slate.

Old red sandstone.—Amherst Collegiate Institution stands very near the line of junction of this rock with the granite.

Coal formation.—Mount Toby rests immediately upon the granite and mica slate; but in order to give the geological position of Amherst College, it was necessary to introduce the old red sandstone, (which also reposes on granite in Amherst,) partly between this mountain and the granite.

Alluvium.—Along the Connecticut.

Greenstone.—Forming a bed between the coal formation and the old red sandstone.

Old red sandstone.—Forming the mountain east of the village of Deerfield.

Alluvium.—Along Deerfield River.

Sienitic granite.—Very similar to that in Belchertown and Ludlow. It extends from Whately to Northampton.

Primitive greenstone and sienite.—Most of the greenstone is schistose; and where this structure is lost, it passes into beautiful sienite.

Argillite.—This is introduced from Leyden, fifteen miles to the north of Whately. In Leyden, its relative position as is given on the section.

Mica slate and coarse limestone.—See Journal of Science, vol. VI. p. 37.

Mica slate.—Very irregular and tortuous in general.

Hornblende slate and mica slate alternating.—This may be seen in Shelburne, Heath, Colrain, &c.

Alternations of granite with mica slate.—In Conway, Goshen, Ashfield, Chesterfield, Williamsburgh,

Westhampton, &c. Towards the central parts, the granite greatly predominates.

Mica slate.—Folia perpendicular, or leaning a little to the east.

Talcous slate.—In the west part of Plainfield. I have traced this stratum twenty miles north of Plainfield, into Vermont.

Chlorite slate.—This stratum is introduced from Whitingham, Vermont. It is narrow, but well characterized. It is succeeded in Whitingham by mica slate on the west.

E. HITCHCOCK.

To the Hon. STEPHEN VAN RENSSELAER.

END OF PART I.